Published monthly by Simmons-Boardman Publishing Corporation, 105 W. Adams St., Chicago, Ill. Subscription price: United States and Possessions, and Canada, $2.00; Foreign, $3.00. Single copies 35 cents. Entered as second-class matter January 20, 1933, at the post office at Chicago, Ill., under the act of March 3, 1879, with additional entry at Mount Morris, Ill., postoffice. Address communications to 105 W. Adams St., Chicago, Ill.

Speaking of Maintenance—
here's some

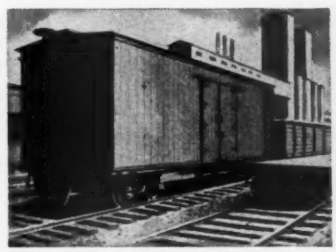
$avings for $ale!

through
DEPENDABLE
PRESSURE TREATMENT!

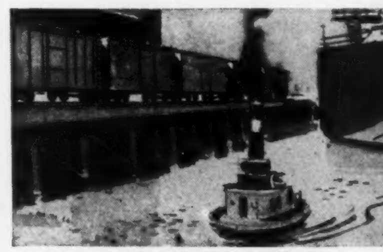
SAVE $$ ON TIES. One mid-western railroad that has 31,533,669 treated ties in track, estimates savings due to longer life at $2,341,090 per year. Another reports an estimated annual saving of $2,880,000.

SAVE $$ ON TRESTLES. A yearly saving of $20,000,000 would result from the universal use of pressure-treated wood in the 13,000,000 linear feet of bridges and trestles now in use according to one authority.

SAVE $$ ON POLES. Railroads maintain more than 4,250,000 poles in signal, telephone, power-distribution and telegraph lines. Savings through use of treated poles are estimated at $10,000,000 a year.



SAVE $$ ON CAR REPAIRS. One railroad reports 14 years service (with more expected) from pressure creosoted car lumber, as compared with 2 to 8 years life of untreated material.



SAVE $$ ON OTHER STRUCTURES. Railroads spend over $90,000,000 in maintenance of buildings and structures. Pressure creosoted lumber can help to cut this cost.

Costs vary, of course . . . but these figures will give you an idea of the savings that the longer life of pressure creosoted wood can bring to you. Cutting maintenance is an easy way to increase operating profit.

OTHER USES FOR PRESSURE-TREATED TIMBER:
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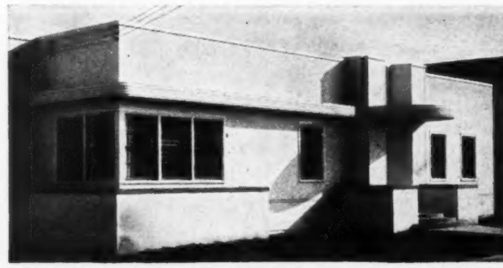
● Douglas Fir Plywood is doing hundreds of jobs for railroads in every section of the country . . . and doing them better and faster than materials previously used.

Every panel of Douglas Fir Plywood is amazingly versatile. It combines large size, light weight, great strength and damage-proofness. To broaden this versatility even more, Douglas Fir Plywood is made in two basic types: Exterior (water-proof) and Moisture Resistant. Each of these types comes in a variety of grades, thicknesses and sizes. Every panel is distinctively "grade trade-marked", too, to make identification and specification easy and positive—to show that it is a quality product made in strict accordance with U.S. Commercial Standard CS45-40.

Write now for Dri-Bilt with Plywood Manual, Grade Use Guide, Sweet's Reprint, Concrete Form Booklet and Finishing Folder. Read them and see the many ways this "Modern Miracle in Wood" can help you solve scores of construction problems. Douglas Fir Plywood Association, Tacoma, Wn.



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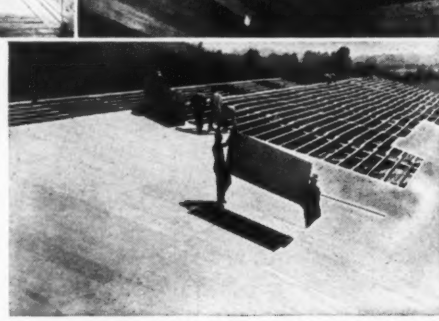
DURABLE INTERIORS? Douglas Fir Plywood is ideal for interior walls and partitions. It is puncture-proof, crack-proof and can be finished in more ways than any other material. It is also a perfect base for linoleum.

CAR LINING? Reduce damage claims. Get ladings to destinations in better condition. Douglas Fir Plywood car lining excludes dirt and cinders, protects ladings from damage. (Photograph: Lackawana box car.)

CAR CEILINGS? *(Above, right)* Condensation is prevented when you use Douglas Fir Plywood in steel-roofed box cars. (New Milwaukee deck loader shown.)

ROOF SHEATHING? *(Right)* Plyscord-grade Douglas Fir Plywood forms a rigid, air-tight, quickly laid base for any type of roofing. On a job with 5 acres of roof, 2 carpenters and 2 helpers recently laid Plyscord at the rate of a carload a day—approximately 50,000 square feet.



FLAWLESS CONCRETE? Douglas Fir Plywood serves as sheathing and lining combined, forms beautifully smooth concrete surfaces. For multiple re-uses, specify Plyform; for one-use jobs, Plyscord.

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MADE LARGER, LIGHTER
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SPECIFY DOUGLAS FIR PLYWOOD BY THESE "GRADE TRADE-MARKS"

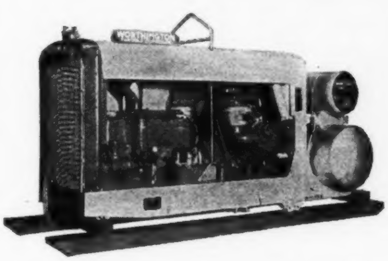
PLYPANEL D.F.P.A.

EXT.-D.F.P.A.

GENUINE PLYSCORD SHEATHING D.F.P.A. INSPECTED

More Railroads are Using More WORTHINGTON in '41

POPULAR WITH RAILROAD MEN



The Worthington Skid Mounted Compressor with Bail Hook can be hoisted on and off flat cars and trucks very readily, and placed in operation almost anywhere along the right of way. Available in 60 to 315 cubic foot sizes—Gasoline, Diesel or Electric driven.

All Worthington Portable and Semi-Portable Compressors are designed for HEAVY DUTY, MODERATE SPEED SERVICE, resulting in maximum overall performance with long life and low maintenance cost. These benefits result from—

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There is a Worthington Distributor or Branch Office in your area that will give you prompt local service.

And there's a good reason. Railroad maintenance men have learned that Worthington Portable and Semi-Portable Air Compressors are built for trouble-free performance, long life, and low maintenance . . . . They've found that Worthington Rock Drills and Air Tools are easy on the operator and give top performance with low air consumption . . . . In short, they know that Worthington equipment saves them money and time on the big job of maintaining a railway.

WORTHINGTON

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Are Leakproof and Maintenance-Free

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Unit of Union Carbide and Carbon Corporation
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Carbide and Carbon Building   Chicago and New York

OXWELD RAILROAD SERVICE

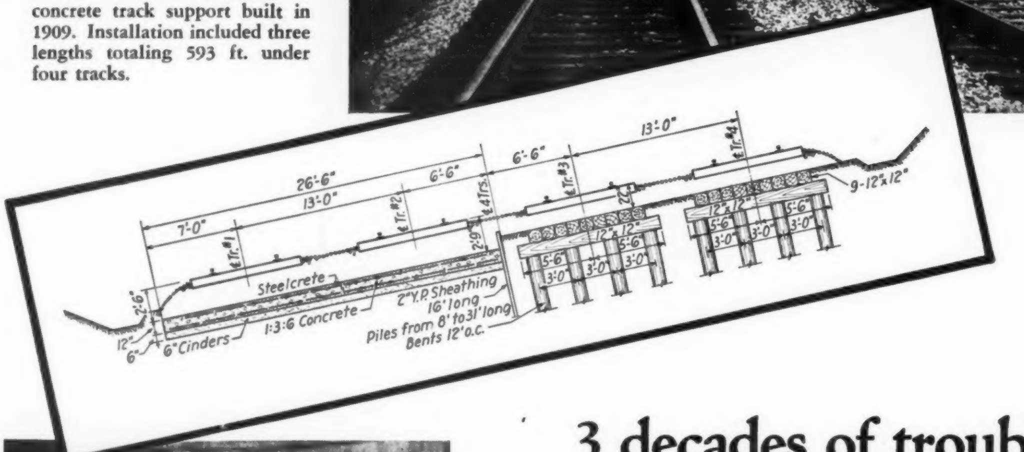
SINCE 1912—THE COMPLETE OXY-ACETYLENE SERVICE FOR AMERICAN RAILROADS

1912

Recent photo at right shows track at Staatsburg, N.Y., where sections of concrete subballast slab 2722 ft. and 353 ft. long were placed under two tracks in 1912. Inspection in 1940 showed them to be O.K. See cross-section below.

1909

(See below) Photograph taken recently at Poughkeepsie, N. Y., shows excellent condition of concrete track support built in 1909. Installation included three lengths totaling 593 ft. under four tracks.



3 decades of trouble-free service prove the economy of **CONCRETE** supported track

Thirty-two years ago at Poughkeepsie, twenty-nine years ago at Staatsburg, the New York Central placed several sections of sub-ballast concrete slabs.

And now look at the record! On these trouble-spots where the underlying material was either soft blue clay mixed with sand, or water-bearing quicksand, the concrete slabs have resisted the battering of heavy main line traffic. The track has given excellent service and remained in good shape with only ordinary maintenance.

With heavy traffic resulting from vastly increased industrial activity, bad stretches of track can seriously handicap railroads during the next two or three years. Right now is a good time to install needed *Concrete Track Support.* It bridges weak subgrades by absorbing and spreading loads. It provides practically uniform rail support at all seasons and over all soils.

Ask for an engineer to call, or write for publication, *"Concrete Supported Railway Track,"* for details of design and construction.

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FAIRMONT M9 SERIES C. 1 to 2 men. Rear lift 95 lbs. Load capacity 500 lbs. Fairmont OD ball-bearing 5 to 8 h.p. engine.

Fairmont

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Performance ON THE JOB COUNTS

FAIRMONT M9 SERIES C, 1 to 2 man inspection car

FAIRMONT 59 SERIES C car in signal maintenance work

FAIRMONT A8 SERIES C, 60 H.P. engine, for heaviest extra gang work

FAIRMONT M19 SERIES D in track supervisor's service

FAIRMONT M14 SERIES D for all light section service

FAIRMONT S2 SERIES E in standard section work

. . . if You Are Using
BARCO UNIT TYTAMPERS!
They do a BETTER JOB *Quicker*

IN OUT OF FACE or SPOT TAMPING

**Each Unit is Self-Contained and
Easily Carried by ONE MAN
No Auxiliary Equipment is Needed**

NOW 73 RAILROADS USE BARCO
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Initial capital expense is lower and year-around performance in tamping, crib busting and ice breaking, add to their efficiency.

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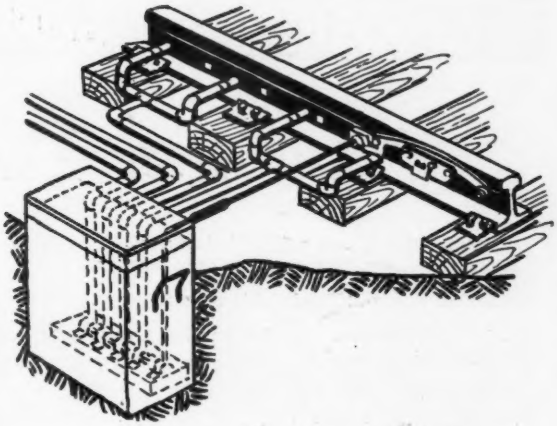
Save Rails and Wheels

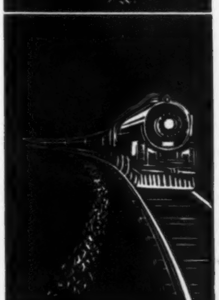


Installations Quickly Paid for by Reduced Replacements

HOW THE LUBRICATOR WORKS

1. *Operator fills reservoir and oils exposed parts.*

2. *Passing wheels pick up grease from the delivery rail.*



3. *And deposit it on the rails at curves which may be several miles away from distribution points.*

Extensive tests with the Racor Rail Lubricator prove that this automatic method of lubricating curves is quickly paid for by the savings resulting from the longer life of rails and wheels.

Rugged construction and simple design of the lubricator reduce inspection and maintenance to a minimum. Installations made at the start of a curve will provide protection for 360° of included angle curvature, since car wheels will carry the lubricant without appreciable waste to the points where it is needed.

RACOR **RAMAPO AJAX DIVISION**

THE AMERICAN BRAKE SHOE & FOUNDRY CO. • 230 Park Ave., New York

No. 150 of a series

Railway
Engineering and Maintenance
SIMMONS-BOARDMAN PUBLISHING CORPORATION
105 WEST ADAMS ST.
CHICAGO, ILL.

Subject: Twenty-Five Years' Team Work

June 1, 1941

Dear Reader:

With this issue we are celebrating a birthday – our twenty-fifth birthday - for it was in June, 1916, that Railway Engineering and Maintenance first appeared within its own independent cover as a magazine of specialized service to you who construct and maintain the roadway and structures of the railways. In a way, we are celebrating our thirtieth birthday also, for in May, 1911, the forerunner of Railway Engineering and Maintenance was started as a special 24-page Maintenance of Way Section in the third weekly issue of the Railway Age of each month. The reception given this specialized section was so encouraging that it blossomed into the full-fledged magazine five years later. It is this latter birthday that we are recognizing specifically in this issue.

The quarter century spanned by the life of Railway Engineering and Maintenance has been one of great progress in maintenance of way practices and materials. While developments in some other departments may have been more spectacular, none has contributed more largely to the progress of the railways; in fact, many of the developments elsewhere, as in streamlined trains, have been possible only by reason of the progress that you have made in strengthening and refining your tracks and structures. And we feel that we may, with due modesty, claim a share of the credit for this remarkable achievement for, during these years, we have made available to all the developments that you individually, here and there, have made, and by this action have greatly hastened their universal adoption as well as stimulating further progress by reason of this recognition.

We claim little credit for originating new ideas; you have done that. Our part has been to make your ideas, your discoveries, available to others in a limited period of time, and conversely, to bring to your attention the developments of others. It has been our function also to stimulate and encourage progress by editorial comment, pointing out deficiencies or needs here and commending achievements elsewhere. All in all, our service has represented a form of teamwork between us.

As Railway Engineering and Maintenance has come to you month after month, so regularly that it has become a part of your daily routine, it would not be surprising if you gave little thought to the accomplishment that this represents over the years. I am going, therefore, to give you a few figures.

In these 25 years, 300 separate issues of the magazine have appeared; this issue starts the fourth hundred. These 300 issues have brought you nearly 23,000 pages of information, divided between 12,062 editorial and 10,789 advertising - forming a shelf of books more than four feet long. To refer to a single classification, we have published nearly a thousand (935 to be exact) articles dealing with or descriptions of work equipment in its many forms. And in our Questions and Answers department, probably the most universally read and quoted phase of our service, we have published the answers to 1,920 questions since this department was established in January, 1921.

We are proud of this service; we are proud of the co-operation that we have received from you as readers, as authors and in so many other ways throughout these years. And if I may be privileged to add an intimate personal word, I am proud of the fact that throughout these twenty-five (and in fact, thirty) years it has been my privilege to direct this service as editor. With me, Neal Howard, managing editor, greets you with 15 years' service; as do Merwin Dick, eastern editor, with 12 years; and George Boyd and John Vreeland, associate editors, with 15 and 3 years' association, respectively.

It is the hope of all of us that our association with you may be as happy, and the results as constructive for the railway industry, during the next twenty-five years as they have been in the quarter century just closed.

Yours sincerely,

Elmer T. Howson

Editor

ETH:EW

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Published on the first day of each month by the

SIMMONS-BOARDMAN PUBLISHING CORPORATION

105 West Adams Street, Chicago

NEW YORK
30 Church Street

CLEVELAND
Terminal Tower

WASHINGTON, D.C.
1081 National Press Bldg.

SEATTLE
1038 Henry Bldg.

SAN FRANCISCO
550 Montgomery St.

LOS ANGELES
Union Bank Bldg.

Subscription price in the United States and Possessions, and Canada, 1 year $2, 2 years $3; foreign countries, 1 year $3, 2 years $5. Single copies, 35 cents each. Address H. E. McCandless, Circulation Manager, 30 Church Street, New York, N.Y.

Member of the Associated Business Papers (A.B.P.) and of the Audit Bureau of Circulations (A.B.C.)

PRINTED IN U.S.A.

Railway Engineering and Maintenance

NAME REGISTERED U. S. PATENT OFFICE

JUNE, 1941

1916– 25th Anniversary Issue –1941

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Railway Engineering and Maintenance

1916-1941

A Quarter Century's Development

ONE of the characteristics of the new air-conditioned streamlined trains is that they give the passenger little realization of the speed with which they are moving. It is only when one looks out the window and notes the passing of objects along the right-of-way that he becomes aware of the rate at which he is traveling across the country. This is true as well of the progress that engineering and maintenance of way officers are making in the development and refinement of their methods of track and structure maintenance. It is equally true of the progress that manufacturers are making in the development of new and the improvement and perfection of old materials and equipment applicable to this work. Working hand in hand, railway officers and manufacturers alike have contributed to the greatest quarter century's progress in maintenance procedure that the railway industry has ever experienced.

In this issue, which marks the twenty-fifth anniversary of *Railway Engineering and Maintenance,* we are taking measure of this progress by comparing present day procedure with that of a quarter century ago and taking account of numerous mileposts in this journey of such steadily increasing tempo—and yet a journey sufficiently short to bring it within the experience of most maintenance men today. By so doing we hope not only to refresh the memory of many regarding the origin of a large number of developments that are now accepted as standard procedure but also to stimulate a greater appreciation of what has taken place in these years and point to the possibilities that still lie ahead.

These developments are described in detail in the pages that follow. Specific references will not be made here, therefore; rather, it will be the aim here to point to some of the influences growing out of these developments.

Enlarged Service

Primary among the results of developments of the last quarter century's practices in maintenance has been the great expansion in the service rendered by the tracks and structures. At the beginning of the period under review, there was a constant race between the track structure and the locomotives. No sooner was heavier rail installed than the locomotive builders and operating officers introduced heavier motive power, again taxing the track to its limit of safe operation and exceeding economical maintenance. In the early twenties, however, other factors, including clearances, came into play to limit further increases in the size of locomotives, with the result that the continued development of the track soon relegated locomotive weights to the background as a factor in determining maintenance expenditures.

In its place came a new criterion—that of the extent to which further expenditures for the improvement of the roadbed and structures could be justified by reduced costs for maintenance. Under this guide, maintenance programs have continued to expand, with greater emphasis on heavier rail, more ballast, better track fastenings, more carefully planned installations of drainage, etc. This development has brought the fixed physical properties of the railways to higher standards, in proportion to the service required of them, than ever before.

Coincident with this strengthening and stabilizing of the track structure, have come refinements in practices that have made possible greatly improved service to railway patrons. Small deficiencies in line and surface, for illustration, that were not considered objectionable a few years ago, are now no longer tolerated. In part, these deficiencies do not develop so quickly in the heavier structure of our day; and they are corrected more quickly.

Building a Reserve

It was the active prosecution of this program of roadway and structures strengthening and rehabilitation during the "twenties" that enabled the roads to carry through the depression of the "thirties," the most acute and the longest continued in history, with the drastically curtailed allotments that were available for upkeep, without lowering the standards of services. From this experience, the roads confirmed the wisdom of their long established policy of ploughing back into their properties as reserves the earnings accumulated in years of heavy business, for it was the expenditures made during the more liberal years of 1923-29 that have made possible the maintenance and still further elevation of our present high standards of service since 1930. The result of these improvements in track construction and maintenance practices has been to make possible the operation of passenger and freight trains alike at speeds that were undreamed of only a few years ago.

We are living in a speed age; whether we like it or not, we face this fact, and the railways must recognize it. That they have done this so markedly is one of the wonders of the industrial world. And it is a tribute to the foresightedness of the maintenance of way department that it was

prepared for this departure when it broke. In fact, on most of these lines, last-minute preparation for these new super-speed schedules has been confined to the correction of minor defects in line and surface and to the lengthening of curve spirals, with no major changes in the track or roadbed structure. And our tracks are now carrying these trains, in every part of the country, at speeds of 75 to 90 and 100 miles per hour with a degree of comfort that is a marvel even to railway officers themselves. It constitutes a great tribute to the maintenance of way department.

Mechanization of Work

An equally important development of the last quarter century, especially from the standpoint of economical maintenance, has been the mechanization of this work. This has been a development essentially of this period, for while certain heavy units, such as steam shovels, dump cars and pile drivers, antedated this period, the development of power-driven equipment for the more common tasks of relaying rail, adzing ties, tightening bolts, tamping ties and framing lumber in the field has occurred during the last 25 years and these units have received such rapid acceptance that their use is almost universal today. Their influence has been profound.

From the standpoint of the railways, the effect has been to give greater uniformity and permanence to the work done, with a marked increase in production and a corresponding decrease in cost. Of late, also, the development of off-track units has greatly reduced the interference with train operation, a consideration of markedly increasing importance with the advent of streamlined passenger train schedules and the corresponding tightening of schedules for freight trains.

And advantages of equal magnitude have accrued to labor. Foremost has been the elimination of most of the drudgery from maintenance, which fact has elevated track and structures work from that of unskilled to semi-skilled and skilled classifications. Furthermore, while mechanical aids have increased the output per man, and thereby reduced the number of men required, they have brought the scale of wages of those employed to the highest level in the history of the railways. In track work, for illustration, the average wage per hour has more than doubled in these 25 years. With this and other developments, such as seniority, positions in maintenance of way work have become much more desirable.

The Manufacturer's Contribution

And while considering the mechanization of maintenance work, one cannot lose sight of the contribution made by the manufacturers. Through their knowledge of machine construction and their application of this knowledge to the practical problems of track work, they have made available equipment that has revolutionized maintenance methods and increased tremendously the efficiency with which such work is being done today.

Because of its universal use, the motor car provides a splendid example. Not only has this car been made far more usable by the application of special metals to reduce its weight, by the refinement of design of the engine to provide greater reliability in operation and marked increase in fuel economy, etc., but it is built today in a variety of sizes to meet all normal requirements. The magnitude of this contribution is evident from the record made by one leading builder whereby the horsepower developed by its engines has been increased from two to three times (from 3 hp. to 8 for one unit and from 5 to 13 hp. for another unit) without changing the bore and stroke of the engines but by refinements in design and manufacture. In still another way the magnitude of this development is reflected by the record of still another company. This company (long established in other fields) first entered the railway field in 1925 when it introduced a power unit for track work. Following this, it introduced a machine for another track operation in 1929 and year by year has added to this line until today it is building a number of machines for different purposes, several in different models, and all widely used.

What these companies have done, many other companies are doing in other directions and in varying degrees, until today work equipment is recognized by builder and user alike as an essential aid of proven merit in maintenance work. And the end is not yet in sight, for new units for new purposes and improvements and refinements in older units are appearing more frequently today than ever before. It is a development in which the railways have already invested more than $100,000,000, and to which they are now adding at the rate of $7,000,000 a year.

No review of maintenance of way progress would be complete without reference to the greatly improved conditions under which the men work today, as regards hazards to life and limb. Throughout all industry, the progress which the railways have made in reducing accidents is recognized as outstanding. And within the railway industry itself, maintenance of way forces have kept pace with other branches of service, in spite of the inherent hazard attending many of its activities, for in the 15 years from 1923 to 1938 casualties among maintenance of way employees were 70 per cent less per million man-hours worked than in 1923 and the record for the entire quarter century is even more pronounced. This record has been made possible primarily by the new emphasis that has been placed on safe workmanship. It has been aided also by the replacement of many manual operations with mechanical equipment which has eliminated lifting, strains, injuries from falling materials, etc.

The Future?

And what of the future? The risk of the prophet is great. Yet certain trends have developed sufficiently to permit one to project them with some degree of assurance. First among these is that of speed. This development has come on us during the last five years with a suddenness that has been staggering. And yet the track and structures have met the demands that have arisen to date with a success that has been gratifying, to say the least. But have we reached the limit of these demands? We do not think so. The public is speed-conscious today. It will give its patronage to that agency that gives it fast service, and with it dependability. No single measure that the railways have initiated has tended more largely to restore them to public favor than the initiation of faster service. And the further speeding up of this service will win still more favor.

Present tracks and structures are capable of withstanding speeds higher than those now prevailing. The limiting factors lie elsewhere—notably in the design of the locomo-

tives and the curvature of the lines. Progress is being made in the solution of both. Locomotive builders are producing epoch-making improvements in locomotives to reduce the destruction of track at high speeds, through refinements in design and through the utilization of lighter, higher strength steels. As to curves, a number of roads are already engaged in definite programs of reduction to as low as one degree, a standard which requires little reduction in speed below that permissible on tangent track. Just as the beginning of the last quarter century saw the railways engaged in a wide program of grade reduction, they are now at the threshold of a widespread program of line improvement to reduce curvature, a program that will involve vast outlays but that is imperative if the railways are to meet the demands for greater speeds.

All in all, it is to be expected that the ability, resourcefulness and initiative that now characterize railway managements, plus the advantages inherent in rail transportation, will carry the railway industry to heights in the next quarter century that are as far above the levels of today, as these levels exceed those of 25 years ago. As this occurs, those who know the men who comprise the maintenance of way department know that they and the manufacturers who provide their needs, will exceed the demands made upon them. The years that are ahead are fully as challenging and as promising of further progress as any we have yet experienced.

My Job

A Dollars-and-Cents Viewpoint

ALL of us have read the saying "For want of a nail, the shoe was lost.—For want of a shoe, the horse was lost.—etc.,"—culminating in the downfall of a kingdom. This saying is valuable for it teaches that small details, if overlooked, may lead to disaster and that the success of any great enterprise depends upon the faithful performance of duty by many. Many tasks involve minor details, as compared to the size or scope of the enterprise as a whole; yet an apparently insignificant task, if improperly performed or neglected, may lead to disastrous results. In no case is this more true than in railroading, and particularly in maintenance of way and structures work.

In these days of world turmoil, with national defense responsibilities adding new problems and duties for every one, the American transportation system may soon be taxed to the limit of its capacity, and in responding to this demand the railroads will bear the major share of the burden. It is easy to see how important the conscientious performance of one's daily tasks may become under such circumstances.

There is another viewpoint, however, that reflects the importance of each man's job in the maintenance of way department. That is the viewpoint of responsibility from a dollars-and-cents standpoint. A track supervisor in charge of 80 miles of line, is custodian of an investment of perhaps $75,000 a mile, or $6,000,000. In addition, each train that passes over his track carries numerous passengers or thousands of dollars worth of freight, to say nothing of the value of the equipment itself. When viewed in this light, the importance of his responsibilities justifies a pride in one's job and encourages him to do even the most insignificant tasks to the best of his ability.

Most of us would benefit by thinking constructively and analyzing the importance of our responsibilities as a whole, rather than being discouraged, as some of us may be occasionally, by the multiplicity of what appear to be relatively unimportant tasks.

Yards

Who Should Renew Ties and Rail?

AFTER more than ten years of reduced traffic and lean earnings, the railways are faced with a sudden increase in car loadings that is making it necessary to go back to 1930 to find comparable figures. More cars loaded means that more cars will pass through yards and that yard tracks must be in condition to permit the added traffic to pass over them.

In general, main-track maintenance has been kept to a commendable standard throughout the lean years, but in many cases at the expense of other tracks, including those in yards. Few maintenance officers will contend that their yard tracks have not deteriorated to some extent, while some admit frankly that a disturbing amount of deferred maintenance has accumulated during the difficult period from which we are now emerging, at least temporarily. There are few yards in which no tracks need more than normal tie renewals, while both ties and rails will be needed on many tracks if they are to be put into condition for present and prospective traffic.

During the last decade track forces have been reduced far below a level that was considered possible before these cuts were made. While this was admittedly necessary, it placed a serious handicap on maintenance in yards, for yard gangs, in common with other regular gangs, were cut to the irreducible minimum and, in general, such additional men as have now been assigned to them are no more than enough to carry on routine maintenance.

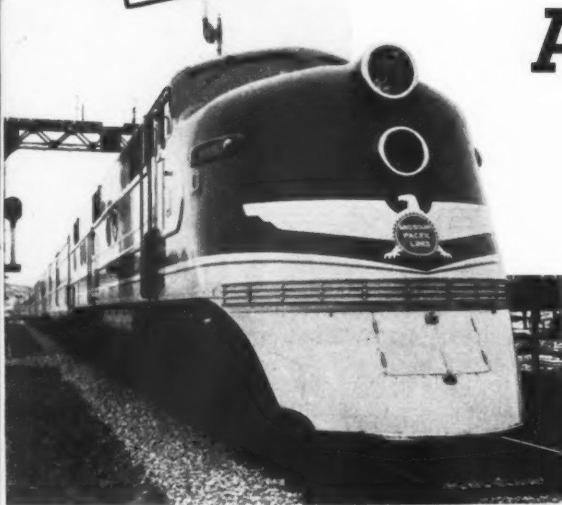
This raises the question as to how tie and rail renewals shall be made. Maintenance officers are not a unit with respect to the use of extra gangs in yards; some prefer this method, while others prefer to use augmented regular gangs. In view of the reductions in force, however, yard gangs generally lack experienced men to carry on the larger operations of tie and rail renewals. This work cannot be done piecemeal, for a track cannot be taken out of service indefinitely, but must be hurried to early completion as soon as it is made available. Again, few yard foremen are able to give their undivided attention to such work.

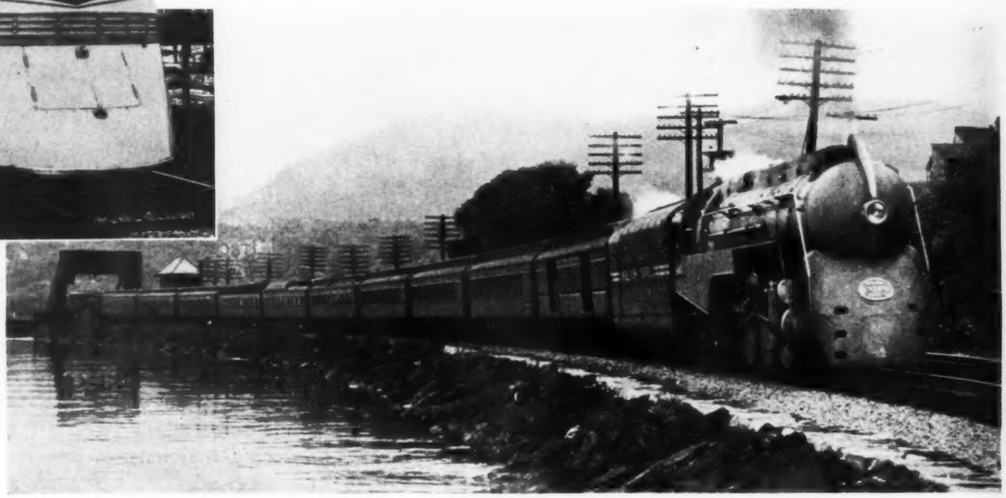
Extra gangs are organized for particular classes of work, and the foremen are or should be capable and experienced. They will be free from interruptions to do routine or emergency maintenance, and will be able to concentrate on the work in hand, insuring a larger output than can be produced by the regular forces. In a busy yard, it is essential that interference with and interruptions to yard operation be kept to the minimum, even for essential track maintenance purposes. An extra gang, headed by a capable foreman, will generally interfere less with these operations than a regular gang.

1916

A Quarter Century

Brings Many Changes





It is a Different Kind of Railroading Today, With Streamlined Trains Operating at Scheduled Speeds of 75 to 90 m.p.h. and Top Speeds of 100 to 110 m.p.h.

AS true as was ever said of the "old gray mare," railroading today "ain't what she used to be," a quarter of a century ago. By the end of 1916, the year in which the first issue of *Railway Engineering and Maintenance* was published, the boom period of railway expansion had ended, and in that year, railway mileage in the United States reached its peak. In fact, the boom days of railroad expansion reached their zenith in 1890, the decade immediately previous to that date having witnessed the construction of more than 70,000 miles of lines alone, including the completion of several transcontinental lines. From 1890 to 1916, railway construction consisted mainly in the building of branch and feeder lines, to round out the country's far-flung railway systems.

Physically speaking, with more mileage, equipment and traffic, there was "more railroading" twenty-five years ago than there is today,—but it was a "different kind of railroading." As this article points out, the theme of the railways in recent years has been speed, comfort, safety and service, with maximum efficiency and economy—a theme that has brought forth marked advances in all forms of railway construction and maintenance work

The next 25 years to 1941, constituting the last quarter of a century, found the railways, successively, passing through the World War period under government control; consolidating and exploiting their gains of earlier years; struggling with periods of peak passenger and freight traffic; plunged into the worst depression in the history of the country; faced with rapidly growing competition from pipe lines, and highway, inland waterway and the air transport; and fighting their way back with revolutionary changes in operation, equipment and methods in a new era of transportation, and preparing today to meet what may develop into peak demands again as the result of the country's huge national defense program and the possibility of a national military emergency.

Different Kind of Railroading

Twenty-five years ago, and continuing for the first half of the last quarter century, it may be said that, measured by the physical plant and the amount of traffic handled, there was more railroading than there has been during the last half of the last quarter century, and even more than there is today. In 1916, there were 254,251 miles of railway lines in the United States, compared with 235,000 miles in 1939.* In 1916, the railways owned 52,179 passenger train cars, whereas in 1939, they owned only 38,427. In 1916, they owned 2,253,233 freight train cars, while in 1939 they owned only 1,671,712 such cars. These figures show that railroading in 1916 involved a larger plant than today, but equally convincing figures are available and will be cited to show that it was a different, less intensive, kind of railroading.

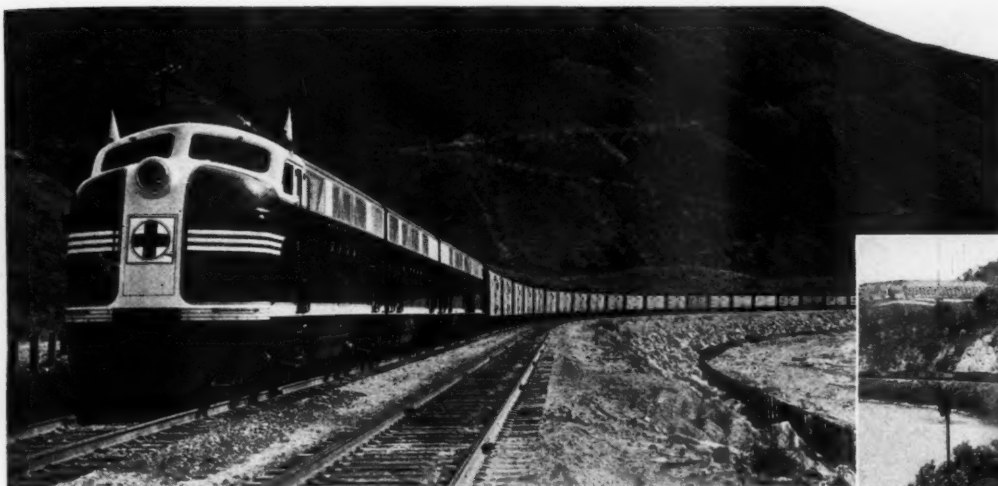
In 1916, the railways of the country handled approximately 1,006,000,000 revenue passengers and about 40,000,000† carloads of freight, and at that time the volume of both passenger and freight traffic was on the increase, with little thought that this increase would not continue indefinitely and remain unchallenged. The railways had already made marked progress in plant and capacity and were rendering an invaluable service

*Where 1939 figures are used, they are the last available.
†Estimate, actual figures not available.

1941

in Railroading

in Maintenance and Construction



The Day of the Freight "Drag" Has Gone, as the Speeds of Freight Trains Today, Both Steam and Diesel, Are Approaching or Exceeding Passenger Train Speeds of Only a Few Years Ago

to the public and to the country as a whole. However, looking back, in the light of what has taken place during the last 25 years, it is not too severe to say that they were entirely too complacent in their false sense of security, and were almost entirely oblivious to the serious conditions that were to confront them in the years ahead.

During the last quarter century, and, more particularly during the last decade, this situation has changed. First, within this period, the railways were shocked into largely increased and more stringent demands occasioned by the first World War; subsequently, in what has been termed the "Roaring Twenties," to 1929, they experienced new peaks in demand, far outstripping those of the war, only to be thrown into the depths of the recent depression, with serious losses in passenger and freight traffic, occasioned both by the depression itself and by the inroads of competition. In all, it has been a period of radical fluctuation in traffic, earnings and demands, with corresponding seasons of increased spending and retrenchment—and almost throughout, the railways were confronted with increasing competition, increasing regulation, increasing taxation and increasing demands for economy.

So severe were the blows of these latter years that there were many who thought that the railways could not recover—could not come back—and who were ready to relegate them to a secondary position in the future transportation picture of the country. That these appraisers and critics of the railways were wrong, and that out of the depression is emerging a railway industry vibrating with new life and determination, with faster, safer and more adequate service than ever before, and with luxuries and comforts in passenger travel unthought of as recently as 10 years ago, marks one of the most outstanding achievements in the transportation and industrial life of the country.

New Operating Methods

Today, from a beginning with the first light-weight streamlined Zephyr passenger train of the Chicago, Burlington & Quincy in 1934, there are more than 125 such trains in operation in the country, with many other passenger trains that have been completely modernized with new light-weight streamlined equipment of more conventional design. And today, these trains of new design are traveling more than 75,000 miles daily, on schedules requiring cruising speeds of 75 to 90 miles per hour and top speeds of 110 miles per hour and more.

Likewise, the modernization of freight service, although less spectacular than the streamliner passenger service, is proceeding with equal rapidity, freight train speeds of today approaching and exceeding passenger train speeds of only a few years ago, and making commonplace reductions of as much as 24 hours in former freight schedules between important cities. And all of these results are being brought about with largely increased overall efficiency and economy.

During the last quarter century, the capacity of freight cars and their average mileage per day have increased—the number of cars and average tons per train have increased—and the average length, weight and tractive power of locomotives, and their mileage per day, have increased. In 1916, the average capacity of the freight cars of the railways was 40.6 tons, this increasing steadily to 49.7

Fuel and Water Stops Must Be Reduced to a Minimum Under Present-Day Operation

tons in 1939. In 1916, tons per freight train averaged approximately 590, as compared with 825 in 1940. In 1916, the average tractive power of locomotives in service was 32,721 lbs., whereas the average tractive power of locomotives in service in 1939 was 50,395 lbs. Equally striking is the fact that the average number of miles operated per passenger locomotive per day increased from 110.1 miles in 1920 (the first year for which statistics are available) to 184.3 miles in 1939, and that the average number of miles operated per freight locomotive per day increased from 85 miles to 104 miles in this same period.

Adding to these records of increased efficiency and economy, engine runs have been extended from the days when it was necessary, or was considered necessary, to change engines at intervals of approximately 100 miles, to through engine runs of 800 miles or more; the number and length of water and fuel stops have been greatly reduced, in many cases more than cut in half; locomotive boiler maintenance has been largely reduced, reducing shopping time and increasing the availability of power; yard operations have been greatly expedited, with smoother handling throughout, greatly reducing damaged claims; and co-ordinated rail, bus and truck service and store-door delivery have become widely adopted and extended—Indeed, it is a different kind of railroading than prevailed a quarter of a century ago.

Fixed Property Has Changed

Striking as have been these many outstanding developments in railway service and operating efficiency during the last quarter century, they are no more striking than the many developments that have taken place in the fixed properties of the railways and the methods of their maintenance —brought about, in large measure, by these new standards of operation and extended services. It is a recognized fact that trains can be no faster than the tracks on which they are operated, and thus, the last quarter century has witnessed the development of the track structure to an extent little appreciated by other than those fully informed. This has included the general adoption of heavier rail of improved design and quality; more and better ballast; larger and more durable ties and a sounder and dryer roadbed. Speed, with comfort and safety, has, in addition, demanded a higher degree of refinement in line and surface; the greater integrity of all track and turnout materials and devices; extensive curve reduction work; and the spiraling of all curves in high-speed territory.

Longer engine runs have required the re-orienting of fuel and water supplies; the development of new plants and the abandonment or subordination of others; and the extensive treatment of raw waters to prevent engine failures on the road and to reduce shopping time. Accelerated schedules have called for and brought forth means for the more rapid delivery of water; turnouts permitting movements at higher speeds; and improved, readjusted and re-equipped yards. The changing of terminals and division points, and new forms of co-ordinated and extended freight service, have called for and brought about the alteration and construction of thousands of terminal and freight handling buildings; and the modernization of passenger train service is now stimulating developments in passenger station modernization that promise to have far-reaching effects.

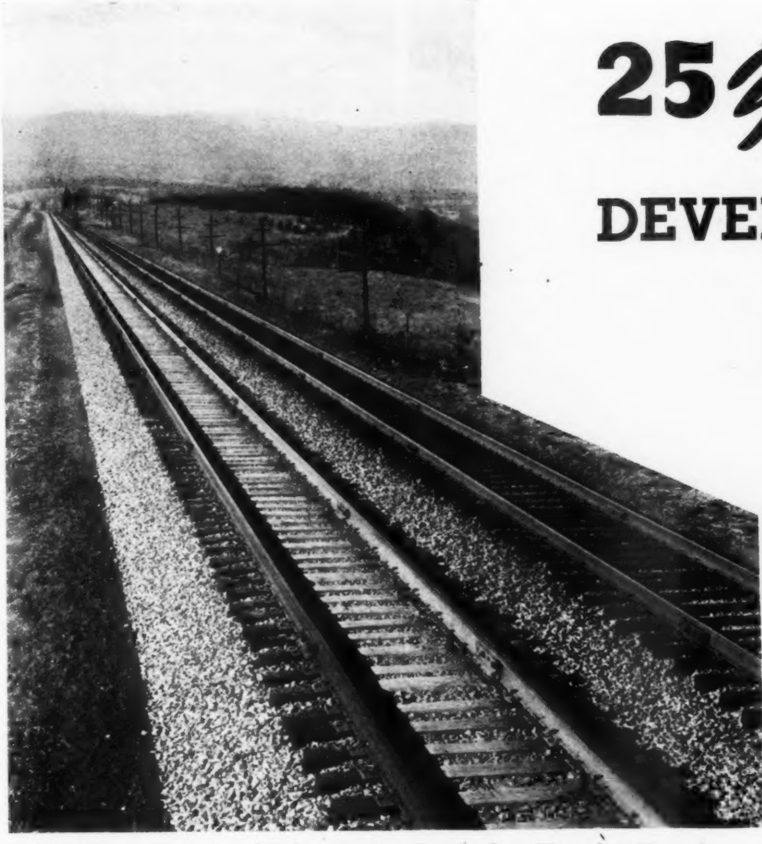
In this same quarter century, under the urge for maximum production, increased efficiency and higher quality work, hand labor in maintenance of way and structures operation has given way largely to machine and power-tool operation, until today, many maintenance operations are as fully and effectively mechanized as most industrial operations. In addition, equipment, organizations and methods employed by the track, bridge, building and water service forces of the railways have been developed and adopted to minimize, if not entirely eliminate, interferences with train operation.

In these and many other ways, the fixed properties of the railways and the methods of their maintenance have undergone revolutionary changes during the last 25 years. Indeed, if they had not, they could have blocked the progress of the railways at many points along the way. Much has already been done, but there is still opportunity for the more general acceptance of the high standards of design, materials, equipment and methods that have been developed. Fortunately, the means and incentives are available to a greater extent than ever before.

What the future holds for the railways, no one knows, but it appears a certainty that with traffic rising to unknown peaks, the increasing tempo of business and industry generally, the constant and increasing threat of competition, and the continuing need for strictest economy, the years ahead will call for continued ingenuity, alertness and energy on the part of the engineering and maintenance of way and structures forces, taking advantage to the fullest extent of every piece of equipment, every new material and every new method that will make for more efficient, attractive and economical rail transportation.

High-Speed Trains, With Their Greater Impact, Have Greatly Increased the Problems of the Bridge Forces

25 Years DEVELOPMENT IN TRACK



Track Today, in Strength and Refinement, Is a Far Cry from That of 25 Years Ago

In the last quarter century track and track maintenance have been revolutionized. Larger rail—better joints —stronger bolts—heavier tie plates —larger ties—more effective anti-creepers — cleaner ballast — drier roadbed—all contribute to stronger track. Power machines have revolutionized gang organizations and have increased the output of labor

ASTONISHING as it may seem to the uninitiated or to the younger men engaged in track maintenance, the track of today differs in no fundamental way from that of 25 or even 50 years ago; yet there is so great a difference that it would be physically impossible for the earlier track to carry today's traffic. Likewise, track materials are basically the same as those that were available 25 years ago; yet those of today bear little semblance to those of the earlier period. Essentially, the requirements for maintaining track have not changed during the quarter century under discussion, although the methods by which this was accomplished would be wholly inadequate today. And the standard of track excellence today is as much in advance of 25 years ago as are the other elements of the track and its maintenance.

Speeds Were Low

When the first issue of *Railway Engineering and Maintenance* appeared, in June, 1916, the average speed of the fastest passenger trains ranged between 45 and 50 miles an hour, and only a few of the most important freight trains averaged more than 10 miles an hour. Second-morning delivery of freight as remote as 500 miles from the point of origin was impracticable in most cases. In contrast, average over-all speeds for many passenger trains have today been stepped up to 60, 65 and even to 70 miles an hour, with top speeds of 100 to 110 miles, and these shortened schedules have been extended into every section of the country. This increased tempo has also included freight service, and first-morning delivery of freight 500 miles from its origin is almost commonplace today.

Dramatic as these increases in speed and the extension of shortened schedules for both passenger and freight trains have been, the track has more than kept pace with the demands that have been made upon it, for the developments that have made this possible began well before the shortened schedules were even considered, although a quarter century ago practically no rail heavier than 100 lb. was in service and most roads were content to use 90 lb. or lighter sections.

With a suddeness that astounded most railway engineers, about 25 years ago, the New York Central, the Pennsylvania and the Lehigh Valley began to lay 127, 130, and 136-lb. rail on their respective lines of heavy traffic or difficult alinement. This action was all the more striking because by 1930, the Pennsylvania had replaced with 130-lb. rail, all of the 100-lb. rail, which had been standard on its lines since 1892, on 8,742 miles of main tracks. While this movement toward heavier rail did not become general at this time, it paved the way for similar action by other roads at a later date.

Again, with a suddenness that was almost breath-taking, in 1933 and 1934, in the lowest depths of the depression, when earnings had almost reached the vanishing point, roads in every section of the country began to lay the new 112 and 131-lb. rail, which sections did not become available until 1933. This was the beginning of a general movement which ante-dated the shortened schedules, and it has been one of the important factors in improving track to the point where it is more than able to meet the demands that are being imposed upon it today.

Startling and sharply defined as these sudden steps seem to be in retrospect, the developments that made them possible were not so sharply defined, for they had been going on slowly for many years. In

fact, the most important step of all in the development of rail in this country, and the one that made all later improvements possible, was taken 76 years ago when the first steel rail was produced in Captain Ward's Chicago Rolling Mill. Second only to this in importance were the 112 and 131-lb. sections developed by the American Railway Engineering Association.

Disaster Discloses Defect

Literally out of a clear sky, a serious hidden defect in the open hearth rails that were then coming into general use—the transverse fissure—was disclosed in connection with the disastrous wreck of a passenger train on an eastern road in 1911. Because it threatened the safety of every train and every passenger on all other roads, intensive study was given to finding the cause and to means for detecting its presence before this was disclosed by a broken rail.

This disaster was the prelude to an amazing chapter in the history of rail maintenance. After a long series of investigations by the railways and manufacturers had failed to produce results, Elmer A. Sperry, who already had an impressive list of inventions to his credit, was asked to undertake the development of equipment for the detection of transverse fissures, and out of his study the detector car was born, which has added so greatly to the safety of train operation. Closely allied to this action, the railways and the manufacturers undertook a joint investigation of the causes of transverse fissures, out of which has grown the application of heat treatment, through the controlled cooling of the rails, which is eliminating the cause of this defect.

Welding to the Rescue

Second in importance only to the improvement in the rail itself has been the perfection of methods for the reconditioning of rail ends, switches, frogs and crossings. From small and scarcely noticed beginnings on the Southern Pacific in 1913 and on the Central of Georgia in 1917, the application of the oxy-acetylene torch in track maintenance spread rapidly. Only a little later, electric welding, which was only awaiting the development of portable generators, appeared in this field. These methods are now applied widely for the building up of rail ends, for restoring worn fishing surfaces on joint bars, for reconditioning worn switch points, frogs and crossings, and for butt-welding rails.

As a natural sequence to the welding of the rail ends, the heat treatment of the rail ends in the track came into vogue about a decade ago. So impressive were the benefits of this treatment that it has spread rapidly; also, alert manufacturers have developed a method for hardening the ends of the rail at the mill.

Grinding an Aid

Closely associated with these developments was another that has become of increasing importance as new applications have been tried. This includes the beveling of the hardened or built-up rail ends to prevent chipping, the surface grinding of the welds to restore the contour of the rail, the removal of overflowed metal on stock rails, the smoothing of the ends of relaid cropped rail, the reduction of high spots on rail with hardened ends, the shaping of frogs and crossings after welding and a wide variety of other applications.

One of the unexpected results of the higher speeds that are so inherently a feature of train operation today, is the disclosure of the inability of the lighter rail sections to stand up under the faster schedules. For this reason, one road after another is replacing its 90 and 100-lb. rail with heavier sections, on lines over which its high-speed passenger and freight trains are routed. In many cases, the rail that is being taken out would have been allowed to remain in service for a number of years longer under the former methods of operation.

Reducing Curves to One Degree to Avoid Speed Reductions, Was a Practice Unthought of a Quarter of a Century Ago

Joints Now Adequate

Through the years, no feature of track construction has caused more concern to maintenance officers or manufacturers than the rail joint. Representing the weakest part of the track structure, it has been given intensive study and a multitude of designs, each intended to overcome this inherent weakness, have been produced. Strangely, it was not appreciated that the low rail sections prevented the girder strength that is needed to support the rail. With the greater fishing height of the 112- and 131-lb. sections, this deficiency has been overcome in part, and, combined with the results of intensive study that has been given joint bar design, by railway men and joint manufacturers alike, employing rolling-load and photoelastic investigations, the rail joint today comes nearer to meeting requirements than at any time in the past.

Among other developments of prime importance to good track as well as to the trackman, is the development of the track bolt. For years no task assigned to the section forces was more onerous or needed to be repeated more often than the tightening of track bolts. The first improvement in this situation came with the advent of the heat-treated bolt, with its negligible stretch under the tensions that are commonly employed. While this marked a milestone in the development of the joint assembly, the full benefit of the improvement was compelled to await a still further development.

It is a curious fact that in many cases some improvement in one device discloses an unexpected weakness in another related one. This happened when the heat-treated bolt was introduced. Previously, spring washers, or nut locks as they were then called, were made of carbon steel, in a flat rectangular section. The inadequacy of this device, which acted merely as a washer, to maintain the tension in the bolts was then fully realized for the first time. This realization started a development which, through extensive laboratory and field investigations, has resulted today in spring washers of alloy steels, that have high reactive values, and which can be relied on to maintain bolt tensions.

Seemingly, nothing could be more prosaic than a tie. Yet it holds a place of equal importance with rail in today's track structure. It is

recognized by progressive railway officers that ties cannot be divorced from wood preservation, for experience has shown that the woods commonly available for tie purposes have a service life of only five or six years if used without treatment, while modern standards demand a life of 20 or more years. Curiously, while the tie had been under development for almost a century, most of the advances that have made the tie of today what it is, have occurred since 1916.

Although it has been attended by no dramatic features, among the important items of this development is that of size. Twenty-five years ago, ties were generally 6 in. by 8 in. in cross section and 8 ft. long, although a few roads were then using ties 7 in. by 9 in. With increasing traffic loads, the latter size came into general use and ties were lengthened to 8 ft. 6 in.

New developments usually create ramifications in unexpected quarters, and the introduction of high-speed schedules was no exception. Up to this time the 8 ft. 6 in. tie had been satisfactory, although this length gives an eccentric bearing to the tie, which increased the difficulty of maintaining line and surface. While most roads have been reluctant to increase tie length, the Atchison, Topeka & Santa Fe took an important forward step in 1940 when it made 9 ft. the standard for ties on its main lines between Chicago and Los Angeles, Cal.

Ostensibly, all roads have maintained standards with respect to size and quality of ties. Actually, competition in procurement or a desire to keep prices down have often led to laxness in the inspection and acceptance of ties, with the result that at times they created almost complete chaos in the field of tie production. In large part these undesirable practices have been corrected of late and, in general, ties are now being purchased in accordance with standards approved by the Association of American Railroads.

No one knows the value of preservative treatment for ties better than the maintenance officer, and this knowledge is not of recent origin, for it was a railway that treated the first ties, more than a century ago, and the railways have been the largest users of treated wood ever since. Yet, in 1916, the year in which *Railway Engineering and Maintenance* made its appearance, less than 35 per cent of the ties inserted in all tracks were given preservative treatment. In contrast, the economic value of tie treatment is so thoroughly established that this ratio has now risen to 86 per cent.

It is a far cry from the claw-bottom tie plates that destroyed so many ties in their day, to the flat, slightly corrugated or stepped plates of today's designs. There is an equally wide difference between the plain tops of former years and the heavy double shoulders of current designs. Thickness, width and length have

Today's High-Speed Passenger and Freight Trains Have Placed Largely Increased Emphasis Upon Adequate Track Drainage

been increased, and independent fastenings have been added. Many of the early plates were cast, malleable or wrought iron; those of today are rolled steel.

Instead of the single purpose that animated the early designs, modern tie plates serve more purposes than any other single item of track material. They protect the ties against rail cutting; they resist the widening of the gage; through the shoulders, they give lateral support to the rail; the upper face is inclined, to cant the rail; and it is also cambered to reduce the stresses imposed in the rail by wave motion, and to prevent the edges of the plate from cutting into the tie by assuring an equable distribution of the wheel loads.

Anti-Creepers Came Last

Without the anti-creeper, present day speeds would not be possible. No device has done more to improve track maintenance or conserve safety. In view of this, it seems odd that the anti-creeper is the latest of all materials included in standard track construction to enter the railway field. For this reason, substantially all of its development, except that which preceded its initial appearance, has taken place during the last quarter century. Despite this short period, it has undergone many changes in design and in the materials from which it is made, from the bolted grip, through the two-piece malleable anchor to the one-piece high-carbon heat-treated steel device that performs so effectively today.

Shortened schedules do not countenance delays to trains, for minutes lost in making only slight reductions from top speed are difficult to recover, and further reductions make recovery still more difficult. To permit higher speeds through crossovers and junctions, turnouts have been lengthened and equipped with 39-ft. curved switch points and rail-bound manganese steel frogs, with the turnout curve continuous from switch point to frog.

Order has also been brought out of confusion in the design and construction of switches, frogs and crossings, this development having all occurred during the quarter century under review. This has been accomplished through co-operative effort between the Track committee of the American Railway Engineering Association and the Manganese Track Society. During this period, the designs of switches, frogs and crossings have been greatly improved and standardized, but with alternate designs that meet every requirement under widely varying conditions.

Streamliners Stimulate Drainage

The streamliners have upset many preconceived ideas, changed many viewpoints and stimulated action along lines that were sometimes accepted as matters of course. In no other phase of maintenance have they placed greater emphasis than on the need for roadbed drainage. While drainage of the roadbed has been recognized for many years as a prime requisite for stable track, the streamliner, with its demand for line and surface that approach perfection, has made roadbed drainage imperative.

Many examples can be cited where a need has stimulated search for a remedy. In this case, however, the remedy was already at hand and could be applied at once. For more than a decade, corrugated perforated pipe had been employed widely for subdrainage, and maintenance officers were thoroughly familiar with its application and its merits. It remained, therefore, only to make the necessary studies and to extend the use of the material to correct the trouble that had thus been thrust into prominence.

Faster schedules and denser traffic are crowding work equipment from

the rails and, to avoid interference with trains as well as to prevent interruptions to the work, the use of off-track units is another of the current developments. Hand weeding has given way to burning and chemical destruction of weeds, while track, tractor-drawn and tractor mowers have superseded hand mowing. The broom and shovel have stepped aside in favor of switch heaters, and snow removal elsewhere is now fully mechanized. Conservation of rail is being practiced intensively today, and as one means to this end the rail and flange lubricator has a large place in current maintenance programs. Again, ballast-cleaning equipment is reclaiming millions of yards of ballast that was formerly discarded.

Track Maintenance Twenty-Five Years Ago

When the first issue of *Railway Engineering and Maintenance* went into the mail, track maintenance was vastly different from that of today. Section gangs were large and were renewing ties at the rate of 300 to 400 to the mile. Relatively small extra gangs on each division were laying rail or ballasting track, all other surfacing being done by the section forces. These operations were conducted manually, no mechanical aids being available. Rail was small and could be handled by hand with a reasonable degree of safety.

This situation was not without its compensations, however, for the drudgery of the hand car was giving way to the comfort of the motor car, and the old time ditching gang of 200 to 300 men with hand shovels, often working in muck to their knees, had been eliminated by the steam ditcher, which required only a few men to do the trimming. The lidgerwood and plow were being pushed into the background by dump cars and the spreader, and rail loaders operated by trainline air pressure had made their appearance.

Within the year, this country was at war, and shortages of labor became acute everywhere. Where none were available before, power machines and power tools began to appear, causing a profound effect on maintenance practices, which has continued without interruption to the present. The tie tamper, which was the forerunner of many of the wide variety of track machines today, took general surfacing out of the hands of the section forces and transferred this work to large gangs that could assure a high use factor for the equipment.

Rail sections were growing heavier and men were getting scarcer, and the rail crane became essential for laying rail. The capacity of this machine to lay rail placed this operation badly out of balance with the remainder of the work. More men were needed to pull spikes, to uncouple the rail and throw it out, to adze the ties and to do other preliminary work, so that the crane could be worked to capacity. Likewise, more men were needed to set the joint bars and bolt the joints, to gage and spike and to do other follow-up work.

The gang grew until it became unwieldy, some of the units being so large as to create confusion. Thus a demand arose for further mechanization, which was met eventually by the mechanical tie adzer, the spike puller, the power wrench, the cutting torch, the pneumatic spike driver and other equipment. As more and more power machines became available, it was possible to synchronize all operations, so that all units moved forward at a uniform pace.

It costs money to own power machines and, while they demonstrate marked economies, they must be used continuously to realize the largest profit from them. It was not feasible to equip division gangs for laying rail, but one large gang could serve several divisions, and thus the specialized regional and system rail gangs came into existence. As the economic benefits began to be realized, this idea has been expanded to include specialized gangs for ballasting, for renewing ties and for tightening bolts.

Maintenance Methods, Such as Rail Laying, Have Been Revolutionized Since 1916

Division extra gangs were inefficient. Being relatively small, the men could not be given assignments to be followed continuously, but were shifted from one job to another as need arose. In the evolution of the specialized gang, this error has been corrected. Today surfacing and ballast gange, like those engaged in laying rail, consist of separate units, in each of which the men are assigned to specific tasks, in which they soon become proficient and always know what is expected of them. As a further expedient for increasing the output without increasing the burden of labor, it has become increasingly the custom on multiple-track lines, where possible without delaying traffic, to divert traffic around the specialized gangs during the working period, thus increasing their efficiency from 25 to 40 per cent.

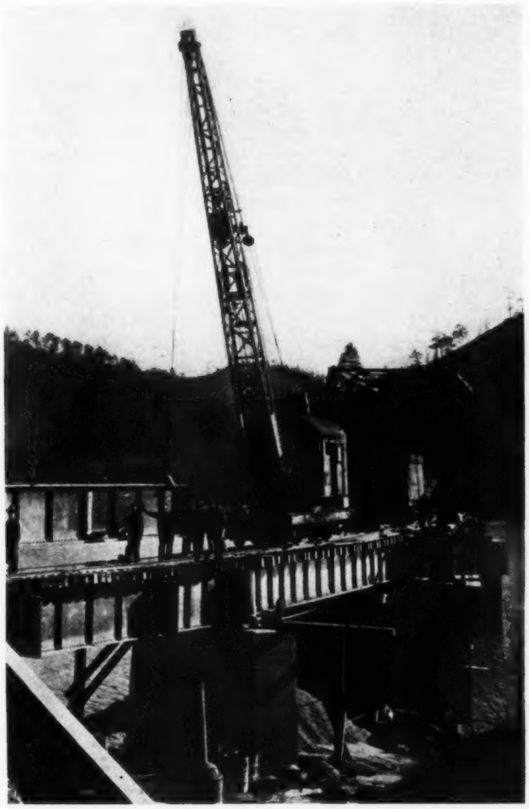
These developments have had a profound effect on the section forces for, as the various classes of work have been transferred to the specialized gangs, section limits have been extended and the section gang has been reduced to a skeleton organization. To add to the efficiency of the large rail gangs, some roads are now providing a duplicate complement of rail-laying equipment and are using two identical gangs, each replacing one line of rails in the track, to avoid making retrograde movements with the equipment, with the loss of rail laying time which this involves.

Maintenance Revolutionized

Just as the streamliner has revolutionized transportation, it has revolutionized maintenance practices. Track work must now be done without slow orders. Small variations in line and surface must be corrected when they occur. These trains are rarely diverted around specialized gangs. Curve elevation must be maintained near perfection. In other words, while line, surface and gage are still the essentials of good track, they are being maintained to higher standards than ever before and, by comparison with 25 years ago, the track rides more smoothly and is safer than it was for the speeds of the earlier day.

Track is stronger today. Heavy rail, large tie plates, larger ties with longer life, more effective anti-creepers, better rail joints, stronger bolts, better ballast and drier roadbed have all combined to produce a structure that is able to meet the demands that are being made upon it. The maintenance forces now have at their command an impressive array of mechanical aids that were entirely lacking a quarter century ago, and are able to meet the exacting requirements for stronger and smoother-riding track with less effort than was expended on the lighter track of a quarter century ago.

25 Years DEVELOPMENT IN BRIDGES



Both Through and Deck Plate-Girder Spans Have Replaced Many of the Lighter Trusses, as Wheel Loads Have Grown Heavier

Bridge design is partly exact science and partly empirical. Nevertheless there has been marked development in both phases during the last quarter century, which has exerted a strong influence on bridge construction and bridge maintenance. Maintenance has made as great advance as design. This article follows these developments and shows their interrelations in this period

IN this rapidly moving age, it is easy to overlook the extent to which practices of 25 years ago would be inadequite to meet current requirements in railway operation and to fail to appreciate how present-day methods have developed. Bridges are no exception, for fully as marked advance has been made here as in the general run of railway construction and maintenance. In addition to new materials, new practices in design and construction, and new methods in maintenance, the bridge forces of the railways now have at their command an imposing array of power machines and power tools that were not available to them a quarter century ago.

No feature of bridge work has changed more radically or shown more improvement than design. Bridges are built primarily for utility, and 25 years ago railway officers saw little virtue in adding to their cost for the sake of improving their appearance. The result was that, in the main, railway bridges were not attractive and the most optimistic could find little architectural merit in them. Even grade separation structures often detracted from their surroundings in rural communities as well as in metropolitan centers.

Architecture Improves

When federal appropriations became available for grade separations, there arose a general demand for architectural treatment of the structures carrying the railway over the highways, and this has now become established practice. The result has been that, even in isolated rural situations, the grade-crossing structures built since 1935 generally present a pleasing and attractive appearance. While the time has been too short for this to be reflected to any appreciable extent in other types of railway bridges, so widespread a practice, which ramifies into every section of the country, cannot fail to have some repercussion on their design.

Increase in Strength

Strength is the most important element in bridges. Twenty-five years ago, bridges designed for the equivalent of Cooper's E-40 loading were not uncommon in main-line service, but, as locomotives and cars increased in size and wheel loadings became heavier, these structures of necessity gave way to structures capable of carrying E-60 and E-72 loadings. Closely associated with this increase in strength, plate girders began to replace the shorter and lighter trusses of the earlier era, improving appearance and reducing general maintenance, until today plate-girder spans of 125 to 150 ft. are not uncommon,

and even longer spans have been installed. In large part, however, these developments in design have been made possible principally through improvements in rolling-mill equipment and manufacturing practices.

A Striking Change

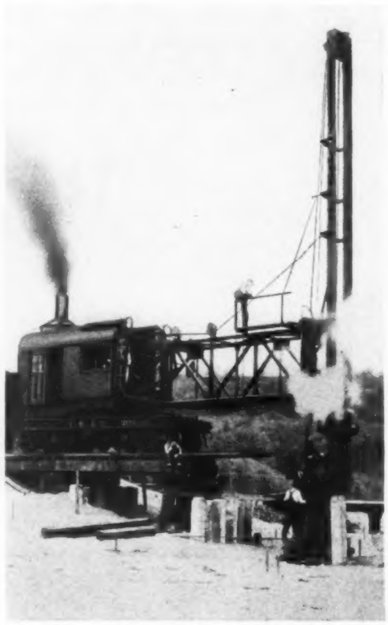
One of the striking changes in steel bridge construction in recent years, which can be traced to better mill practices, is the substitution of solid-rolled wide-flange sections for built-up members. Of late years, a large number of such sections have become available, ranging up to 36 in. deep and weighing up to 300 lb. per ft., for beams; column sections as heavy as 16¾ in. by 18¾ in., weighing 426 lb., have also become available, and these can be increased by adding cover plates to the flanges. Another development in design that can be traced to better mill operation is the use of alloy steels, particularly silicon steel which permits a reduction of about one third in the weight of members, thus making the cost of long-span bridges appreciably less.

At the same time, there have been similar improvements in the details of design. Riveted connections have almost wholly replaced the pin connections of the former era; floor systems have been strengthened; solid diaphragms are replacing lacing bars in compression numbers; and rivets have increased from ¾ to ⅞ in. to 1, 1⅛ and 1¼ in. in diameter. While there has as yet been no general movement toward the substitution of welded for riveted connections in bridge fabrication, this practice, which is being used to a considerable extent in the erection of steel-frame buildings, is slowly finding its way into the railway field, but has as yet been used too short a time here to determine its probable future in this field..

Evolution of the Trestle

Wood trestles in service on the railways have a combined length of approximately 2,500 miles. While the use of creosoted material for these structures was well developed prior to 1916, a much more universal application of this material has been made during the last quarter century. More recently, a few roads have replaced many of their timber structures with concrete-pile bents supporting wide-flange beams, with concrete floors for ballast.

Better foundations for railway structures are now the order of the day, to prevent settlement, to insure against scour and to eliminate drifting. In this movement for greater stability, structural and tubular steel bearing piles are coming into use for both trestles and the foundations for masonry substructures; the use of creosoted-wood piles is expanding; and concrete piles are being made



Concrete, Steel and Creosoted-Wood Piles Are Being Used Widely for Both Trestles and Foundations

larger. As evidence that solidity is not being overlooked in the design of these structures, concrete piles up to 24 in. in diameter are being used in the construction of concrete trestles.

Rigid Frames Developed

Better construction at less cost has been the constant aim of bridge designers for many years. Working along this line, a new type of structure, known as the rigid frame, in both steel and concrete, has been under development for about a decade and is now being applied in numerous present-day designs. Concrete structures of this type, as well as of the flat-slab type, which was in use prior to 1916, have been built with ballastless floors, that is, with the rail resting directly on the concrete without intervening ballast. On the other hand, the ballast deck is coming into more general use for steel spans, to improve the riding qualities of the track, to dampen impact, to eliminate fire hazards and to reduce maintenance costs.

As a corollary to the ballast floor on steel spans, solid plate floors of wrought iron and steel are being substituted for concrete slabs as the support for the ballast, since they weigh less and the floor is shallower. This practice is also being extended to open-deck grade separation structures to protect users of the highway from dripping oil and falling objects.

Many of the early designs were prepared with little consideration for maintenance. Today this is in mind constantly, and bridge maintenance is being greatly simplified. In the past many steel bridges have gone to the scrap pile because corrosion had weakened the members. Today, one of the notable improvements in design is the addition of small increases in sections here and there in realization of the fact that such additions afford cheap insurance against this form of failure at an almost negligible increase in cost. Another notable improvement is the rocker expansion bearing to replace the roller nest that never long remained straight or functioned as a roller.

Extensive Evolution in Culverts

Few, even among those most intimately connected with their maintenance, realize that the railways are maintaining 640,000 culverts. First of wood, then of stone, followed by cast iron pipe, concrete boxes and arches and concrete pipe, about 20 years ago corrugated metal pipe entered the railway field eventually finding favor for openings up to 7 or 8 ft. in diameter. Because of its light weight, insuring easy handling, it has supplanted many of the so-called permanent materials. Improvements since its introduction include methods for jacking the pipe through fills, paved inverts to overcome wear and rust-resisting coatings to resist unusually corrosive conditions.

Keeping Them Out of the Scrap Pile

Important as the improvements in design have been, parallel advances have been made in bridge maintenance and, of these, none is of more importance than welding, for many of the structures that have been mentioned might still be functioning satisfactorily if welding equipment and welding technic had advanced to their present stage of development at the time these structures were discarded. The first large job of strengthening a bridge by welding to save it from the discard was that done on the Chicago Great Western structure over the Missouri river at Leavenworth, Kan., in 1927. Since then, equipment and technic have been greatly improved.

Bridges require dependable support, and extended deterioration of the masonry substructure may endanger the stability of the bridge and create the need for large expenditures to replace it. For this reason, bridge

engineers have developed a method of reclaiming many of these old structures by pressure grouting. Equally alert to overcome corrosion, particularly from brine drippings, they are riveting or welding wrought iron cover plates to bridge members to intercept the brine and save the members from further attack. They are also applying liner plates in the replacement of long culverts or those of large diameter to avoid the need for the special equipment and the work involved in the jacking operation.

How Mechanization Helped

Power machines and power tools have revolutionized bridge construction and maintenance. Prominent among this equipment are the fixed machines installed at treating plants for presizing and preboring timbers that are to be treated, as well as the portable machines that are used in the field by the maintenance forces. Twenty-five years ago, after stringers, caps, ties, guard timbers, brace plank

Various Types of Power Units, Many of Them Portable, Are Now Available

and piles were treated, they were framed and bored in the field, as became necessary to complete the erection of the structure. As bridge after bridge failed from decay originating at these points of weakened protection, long before its expected service life was completed, the practice of framing and boring before treatment became an essential practice, and today the thing that "couldn't" be done has become a reality, for long creosoted trestles are being erected without cutting a single member or boring a single hole, except occasionally for brace plank,

No bridge maintenance gang today considers itself properly equipped unless it has a power unit, a compressor, a generator or a direct drive, and an assignment of portable power tools, including saws, wood borers, drills, centrifugal pumps, wrenches, impact wrenches, jackhammers, rivet hammers, rivet cutters, scaling hammers, rotary brushes, power jacks, reversible drills, hoists and similar tools.

Painting Equipment Developed

Paint spraying equipment has not only speeded up the painting of bridges but has improved the finished job as compared with hand painting. Closely associated with the mechanization of painting, the quality of bridge paint has shown a decided improvement over that available to the maintenance forces a quarter century ago. Incidentally also, these forces now have at their disposal rust-inhibiting materials that are dependable for the stopping of corrosion on steel surfaces, and are particularly adapted for use on surfaces where corrosion has already obtained a foothold.

Transportation of the bridge forces has advanced from the hand car to the motor car and has thus given bridge gangs a wider radius of action. The motor car conserves the time of these gangs, which frequently must be moved quickly for considerable distances, and reduces their dependence on trains to get them to their destinations. More recently the motor truck has replaced to a considerable extent the motor car on many roads for the transportation of bridge gangs and bridge materials and is demonstrating that it is particularly effective for the handling of paint gangs, and their equipment, including ladders and staging.

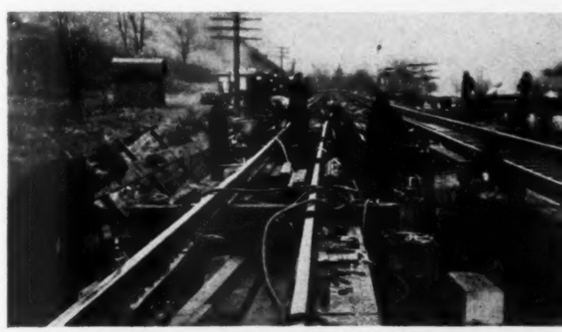
Increased Speeds Cause Changes

No other development in railway operation has had so many ramifications or created so many changes in practices as the introduction of high-speed passenger service. Prior to the streamliner, it was customary for the bridge forces to place slow orders on projected work and then proceed with the project under flag protection. Today, the flag is still sent out to guard against unforeseen situations that might cause an accident, but the structure is more and more being kept in such condition and the work is being planned in such a way that slow orders are largely becoming unnecessary or at least are being kept to the irreducible minimum.

Thus, during the entire quarter century under review, there has been

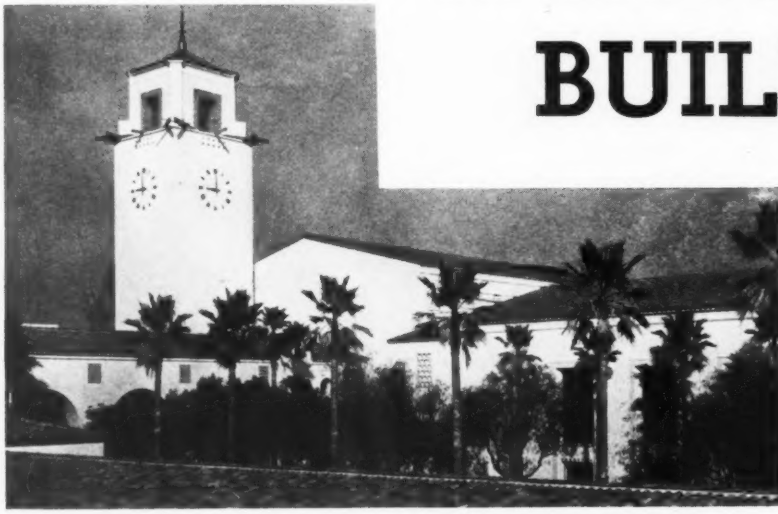
Tools That Do the Work in Less Time Are a Necessity, If Slow Orders Are to Be Reduced

constant improvement in bridge design, as experience has revealed opportunities for better details; as results of extensive column investigations, tests on riveted connections and studies of impact and stresses under moving loads that have made new information available; and as new materials have been developed. At the same time, and recording similar advance, bridge maintenance has kept pace with design and construction as new materials and methods have been developed and become available. Not the least of the factors upon which this advance has been based is the use of portable power equipment, all of which has entered the scene since 1916. Thus, bridges have kept pace during the quarter century with the advances that have been recorded in the other elements of the fixed property, and in many cases have made structures of the earlier period unsightly and obsolete by contrast.



Portable Power Tools Have Caused Drastic Changes in Bridge Maintenance

25 Years DEVELOPMENT IN BUILDINGS



The Colorful New Passenger Station at Los Angeles, Cal., Is Indicative of the Increased Attention That Is Being Given to Appropriate Architectural Treatment

Railway buildings are coming into their own. Materials which have become available during the last quarter century have created a new era in railway building design and construction. These include thermal insulation; flooring, roofing and wall materials; windows; doors, and lighting, heating, air-conditioning and sanitary equipment; all of which are discussed in this article

NO previous period in railway history has seen such amazing developments in building materials and equipment, and in methods of construction and maintenance, as have occurred during the last quarter century. No equal period has witnessed such a re-orientation of ideas regarding the designs for railway buildings as has occurred among railway officers and building engineers. Still more arresting to those who have studied this situation, these changes have not followed the slow process of evolution for, while the bases for them were laid in part during the first half of the last quarter century, most of these developments have actually occurred during the last decade and their impact has been felt most forcibly only during the last three or four years.

Buildings had reached a high state of architectural and structural development long before the beginning of the last century. With the coming of the railways early in the nineteenth century, therefore, there was little new that railway building men could add to the developments of the past, and there is no criticism that they made little or no attempt to do so.

With the rapid expansion of railway lines over the country to 1916, and even in subsequent years, the primary considerations of the building forces have been speed, economy and utilitarian construction. Faced with these considerations of major importance, rapidly changing conditions which made many buildings inadequate or obsolete in a few years; and the mushroom growth of communities along their lines, with buildings of nondescript construction and architecture being thrown up on every side; it is not surprising that the railway building forces of early years gave little attention to architectural appearance. If there is criticism to be made of these forces, it is not that they did not contribute anything new to the advancement in building architecture, but that, in most cases, they disregarded almost completely the outstanding developments in architecture of the past, even as recent as the Colonial period in our own country, in the construction of passenger stations and other important facilities.

Modernization Under Way

By the turn of the last quarter century, in 1916, when the railway mileage of the country reached its peak, many notable railway passenger stations and terminals, fully in keeping with the architecture and physical demands of the time, had been built. And while it is true also that during the next 10 or 15 years a few roads constructed a number of highly pleasing passenger stations in the more important cities and suburban communities along their lines, it is a fact that the railways as a whole by that time still had little appreciation of the possibilities in adequate architectural treatment and appearance, and that it remained for the coming of the first streamlined passenger trains in 1934, with their marked reaction on and acceptance by the public, to shock them into the realization that most of their passenger stations served by these trains were unattractive and uninviting to the public, if, indeed, not entirely outmoded by the new era of speed, comfort, and luxury in passenger train travel.

With thousands of stations outmoded in the light of the new developments; still in the depths of the economic depression; and the realization of the growing public demand for improved facilities, it was a startling and rude awakening. However, from this awakening, in what, unquestionably, has constituted the most outstanding development in the railway building field during the last quarter century, the railways have caught the vision of eye and comfort appeal, and in increasing numbers and expanding programs, have, through renovation, modernization, and, in a few cases, outright reconstruction, been bringing one station after another into step with modern appeal.

Outstanding examples of this are seen in the new Union Station of the

Santa Fe, the Southern Pacific and the Union Pacific at Los Angeles, Cal.; the stations of the Milwaukee at Minneapolis, Minn., and Madison, Wis.; the stations of the Rock Island at Des Moines, Ia.; and the station of the Chicago & North Western at Rochester, Minn. On these roads and a number of others, because of special conditions or the inability to undertake complete modernization projects, individual facilities, such as waiting rooms, toilet rooms and restaurants have been singled out for attention with unusually effective results—in many cases precluding the necessity for more extensive modernization with largely increased costs. And that the programs of the railway in this regard are expanding is seen in the fact that hardly a week passes without the announcement of new projects.

In many respects, what has already been done and lies ahead in passenger station modernization could not have been undertaken to the same extent and degree of effectiveness as recently as a decade ago, awaiting further developments in building materials and equipment. However, such excuse as there may have been in an earlier period in this regard has since been removed as building men now find available to them a wider variety of building materials and equipment than have ever been available before in the history of the building industry.

Only with respect to appearance and furnishings has the recent attention being given to passenger stations been more outstanding than the developments of the last quarter century in many other types of railway building structures, developments that have been making themselves felt on an increasing scale as new or enlarged facilities have been required. Today, while frame construction still plays a large and important part in railway building construction, brick, concrete and steel are considered the fundamental building materials for the larger railway structures, and even these have found effective substitutes for many classes of buildings, in various types of metal and asbestos-cement siding sheets and panels now available, with integral or readily adapted and applied insulation.

Along with these developments in materials in the interest of more durable and fire-resistant construction, with reduced maintenance costs, increased attention has been given to the more efficient and effective layout of buildings to meet changing and anticipated needs; to reduce interior obstruction; to minimize walking and trucking distances in carrying out operations; and to improve working conditions generally. At the same time, as is pointed out later, there have been marked improvements in flooring and roofing materials, in windows, skylights and doors, and in heating plants and equipment, all in the interest of more permanent construction, minimum maintenance and more efficient operation.

By 1916, the earlier common gravity coal dock, of timber construction, had already given way to the mechanical type of coaling plant of concrete and steel construction, although only a relatively few of this newer design had been built by the turn of the last quarter century. Since that time, hundreds of these more modern plants, in capacities up to 1,250 tons, have been built throughout the country, incorporating features of automatic operation and control that were little thought of 10 or 15 years earlier.

Floors Cause Concern

Floors have always given building men much concern, even those in passenger stations, because beyond providing a surface to move over safely, it is desirable that they be smooth, durable, readily kept clean, and, for many localities, attractive—a difficult combination. Soft and hard woods, concrete and various forms of quarried and manufactured tile have long been the fundamental flooring materials employed in station buildings, and, selected judiciously for the particular service, if properly installed, are still satisfactory.

However, the last quarter century has contributed numerous advances in flooring materials in the interest of economy, appearance, increased serviceability and safety, that have been receiving wide acceptance. These include a variety of colorful, non-slip tiles; materials and methods of improving the surface of concrete to increase its wear resistance and to prevent dusting; and colorful linoleums and asphalt tile patterns for areas deserving of special treatment and subject to moderate service. In addition, and especially for resurfacing worn and uneven floors and platforms, a number of mastic surfacing compounds have become available which have proved highly practical and economical, and which can be applied with minimum interference with normal use of the floor areas.

The original plank flooring in shops, enginehouses and freight houses persisted for many years and still does in many freight houses and in the freight sections of not a few combination stations. This flooring was generally uneven when worn and presented a serious obstacle to trucking. In freight houses, this difficulty was overcome by laying truckways of matched hard maple. In shops and enginehouses, the wood was replaced with brick laid on a sand cushion. The brick wore better but was even worse for trucking, for it settled unevenly and many of the bricks were broken by heavy objects dropped on them.

While some of the materials to be mentioned were used for flooring more than 25 years ago, since that time creosoted wood blocks and concrete have come into common use in shops and wood blocks and concrete

Modern Materials and Fixtures Are Now Being Used Extensively to Modernize Old Passenger Stations

have largely replaced the older materials in enginehouses. While untreated wood plank and maple runways are still in use in many freight houses, warehouses and piers, there is a definite trend toward the use of other materials, such as concrete and asphalt mastic for freight houses, warehouses and baggage and express rooms, wood blocks also being used for the latter facilities. Of late, one of the outstanding developments in flooring is the use of a relatively new material, creosoted black-gum plank, which is increasing in favor for freight houses, piers, exterior platforms and baggage and express facilities. This material, when sized accurately and laid carefully, gives a smooth trucking surface and is surprisingly resistant to wear.

Likewise, the developments in roofing materials have been equally noteworthy. Prepared and built-up roofing have been in use for many years. Prior to 25 years ago, the asphalt shingle had also been introduced, but had made little headway for railway use because it was too light and curled up with the wind, while its service life was short. Today, in line with the general advance in building materials, these defects have been corrected, excellent material in many designs and having a service life of 15 to 20 years, being available to the building forces. Asbestos-cement shingles have now been in use for slightly more than a quarter century and have also been greatly improved in recent years. Because of their relatively light weight, their ready availability and their demonstrated service life, they have in large measure replaced the slate shingle that was used almost universally on the better classes of buildings 25 years ago.

Windows and Doors

Among the notable examples of improvements in building construction is that of windows and doors. Originally, all window sash and frames were of wood. As the window openings in shops, power plants and other large structures increased in size, it became difficult, if not impracticable, to continue this form of construction. Furthermore, the wood sash and frames offered no resistance to the spread of fires. For these reasons, metal was substituted for wood. Beyond this, there have been many improvements in both design and materials during the last quarter century, including copper-bearing steel and mechanical means for opening and closing sections of large window areas. With the advent of the metal sash, it became common practice to employ wire glass in place of the plain glass formerly used, as an added barrier to the spread of fires. Still more recently, glass building blocks are finding their way into the building field as a substitute for windows.

Of no less importance than in the case of windows, have been the marked improvements made in doors for all classes of railway buildings, and especially for such buildings as enginehouses, shops, freight houses and piers, involving unusually large door openings. In recent years, supplementing the hinged and sliding wood doors of the past, the railways have had made available to them, and have made extensive use of, hinged, sliding, bi-folding and rolling, shutter-type doors, and a variety of vertical-lift overhead-type doors, of both wood and steel construction, and manually or motor-operated as desired.

Heating Equipment

Equipment for heating stations, offices and similar buildings by means of steam and hot water, which was available 25 years ago, has changed little in principle during the quarter century. However, it has been greatly improved and its efficiency has been increased to a marked degree, and automatic control of room temperatures has been added and simplified. On the other hand, a new system of heating, incorporating the conditioning of the air, has come into use during the period under consideration and has reached a high stage of development. In railway service, its most extensive application has been in passenger cars, although several notable installations have been made in stations, offices and fruit houses.

So far as heating such buildings as shops, enginehouses, storerooms, piers, etc., the most important development of recent years has been the unit heater, a unit which can be installed in multiple about the walls or ceiling areas as desired and which has the advantages that heating of large building areas can be localized as desired, and that the heated air can be directed to those parts of the floor area where most required.

Possibly the most outstanding development of many years with respect to heating has been the application of thermal insulation in building construction. While such insulation has been used for many years in connection with refrigeration, it is only within recent years that it has been made available in forms adapted for general building construction. It is now available in several forms, however, so that it can be applied to both new buildings as erected and to existing buildings. Experience has shown that the economy in fuel that is possible when a building is fully insulated, is often sufficient to pay for both the insulation itself and the heating plant in five years or less.

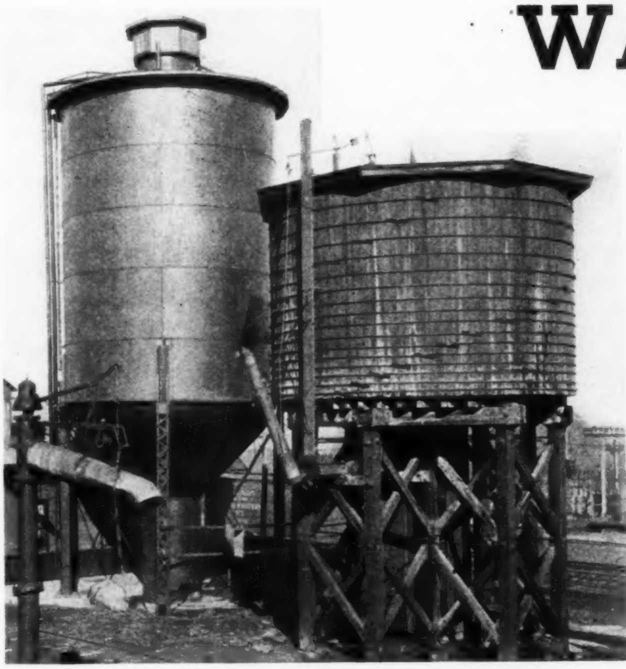
While it can hardly be spoken of as progress, no record of developments in the railway building field during the last quarter century would be complete without mention of the widespread abandonment of railway buildings that has taken place. The programs in this regard have affected practically all classes of buildings on the railways, some roads having abandoned and disposed of as many as 2,000 buildings during the last 10 or 15 years. While reduced taxes and upkeep costs have been the major considerations in this regard, it is significant of the recent trend of thought on the railways that one of the factors involved has been to improve the general appearance of railway property through the removal of many unsightly structures.

Power Tools Now Available

During the last quarter century on the railways, and especially during the last decade, the mechanical aids that have become available to the building forces, and, as a result, the improved methods of carrying out building work, have been as outstanding as the developments in building materials and equipment. Prior to 1916, the building forces had few mechanical aids available to them, other than steam-operated hoists and gin poles. By comparison, these same forces today have a wide variety of heavy work equipment and portable tools, the latter including saws, wood borers, drills, planers, spike drivers, paint sprays, pumps, wrenches, etc., which are not only easing the burden of manual methods, but which are also speeding up work operations to a remarkable degree.

In view of the foregoing, it cannot be denied that many developments have taken place in railway building construction and maintenance during the last quarter century. At the same time, it must be as readily admitted that, following years of neglect and unimaginative attention, heightened to a large extent during the recent severe business depression, there is still room for much further development, and for further adaptation of the developments that have already taken place. Possibly the most significant factor in viewing railway building activity in the future is that in the revival of building activity that is now under way, the railways are showing a definite trend away from previous traditional designs and materials, in favor of the most modern designs, materials, equipment and methods.

25 Years DEVELOPMENT IN WATER Service



Modern Steam Train Operation Would Not Be Possible Without the Marked Progress That Has Been Made in Water Treatment

From a hit-or-miss operation, railway water service has been elevated to the plane of an exact scientific procedure, in which both the quality and the quantity of the supply have been brought under close scrutiny. In making this advance, during the last 25 years, improvements have been made in every phase of water supply, including sources of supply—power units—pumps and pump control—water storage and delivery—and in chemical treating processes

IN NO phase of railway operation, except that of moving traffic, have conditions changed more drastically during the last twenty-five years than in the field of water service. The continued increase in the size of locomotives, the higher boiler pressures, the widespread shortening of train schedules and the adoption of longer locomotive runs have combined to demand water of such steadily better quality, as to bring about a revolution in practically every phase of water supply. As a result, requirements for locomotive boiler waters that are today accepted as a matter of course would have been utterly impossible of attainment with the equipment that was available or the methods that were in vogue a quarter century ago. The last quarter century has witnessed improvements in water-service equipment, materials and methods, the importance of which are scarcely realized by those engaged in this service and are totally unappreciated by others.

The foundations for many of the practices of today were laid in the period from 1890 to 1916. Today, in large degree, railway water-service operations revolve around water conditioning, for few waters are suitable in their natural state for locomotive boiler use, although ample and dependable supplies are of equal importance with quality. The method most commonly employed for softening locomotive boiler waters, the lime-soda ash process, was first applied 50 years ago, in December, 1891, on the Oregon Short Line, now part of the Union Pacific. Five years later, in 1896, the Southern Pacific installed the second plant using this process. Both of these plants were of the intermittent type. In 1900, the Denver & Rio Grande Western constructed a similar plant of the continuous type, at Helper, Utah.

Prior to this time, locomotives were small and water consumption was limited, compared with today. Water stations had been established where water was readily available, little consideration having been given to the quality of the supply. As a result, boilers required almost constant attention, engine failures occurred almost as a matter of routine and boiler maintenance was astonishingly high. As an example of the conditions that prevailed, as late as 1905 one of the larger roads that was then just beginning to treat water, made it a general practice to station relief engines at several points between terminals during seasons of heavy traffic to minimize train delays caused by engine failures.

Advance Since 1916

Despite this demonstrated need for better water, and its growing importance as locomotives increased in size and train loads grew heavier, the idea of softening water for locomotive boiler use developed slowly, so slowly in fact that there were only 480 water-treating plants in operation on the railways in 1916, when the first issue of *Railway Engineering and Maintenance* made its appearance. Lacking means for controlling the introduction of the chemicals into the raw water, both over and under-treatment were common defects of the treating process 25 years ago.

Similar conditions prevailed with

respect to power units, pumps, water storage, the delivery of water to locomotives, pump houses, clarification of water, fuel storage, pipe lines and other items that are necessary for the collection and delivery of the water. It would be practically impossible to provide the volume of water required today with the facilities of 25 years ago. Likewise, long locomotive runs, shortened schedules and dependable deliveries of freight or passengers could not be maintained with water of the quality that was in common use 25 years ago. In other words, the last 25 years have witnessed almost all of the improvements and refinements that have made modern water-service processes and equipment so inherently an essential part of today's streamlined freight as well as passenger operation.

Power Units Improved

The center of the pumping station is the power unit. With few exceptions, the early water stations were steam-operated, but about 1900 a combined gasoline engine and pump was developed and for a time enjoyed wide popularity for small and medium size stations. One of the claims made for it was that it required no attendance, except for starting and stopping, and where the pump house was near the depot, the pumping could be done by the station agent. The advantage thus claimed proved to be a serious drawback, however, for infrequent lubrication and other lack of attention soon increased maintenance costs to such an extent that they offset most of the expected economies. Again, as the use of the automobile expanded, the price of gasoline advanced to the point where the economy of the equipment vanished, so that the gasoline engine never became a serious competitor of steam.

In the search for greater dependability and more economy in pumping, the oil engine was the next step, since it could be operated on heavier and cheaper oils. Following 1916, oil-engine designers attemptel to adapt the Diesel engine, which was then available only in units too large for railway water service, to lighter service, and out of this effort came the so-called semi-Diesel engine. This engine has proved to be satisfactory and economical and has been perfected to such an extent that its operation is as reliable as steam, although it is not as flexible when used with displacement pumps.

As electricity became available with the extension of power lines into many sections of the country, as interruptions to the power current decreased in number and duration and as power rates were lowered, this form of power became attractive because still greater economies were possible through its use. It has the advantage also of being susceptible of automatic control, thereby eliminating the expense of constant attendance. In the intervening years it has been substituted for other forms of power in approximately 27 per cent of the 16,700 water stations in operation today. Remarkable examples of what can be obtained in the way of economy through the electrification of water stations and the application of automatic control are found in plants on the Illinois Central which have been installed without a pump house or a pumper; and on the Southern, where 51 electrified water stations with automatic control are earning 72 per cent annually on the investment necessary to replace the former steam and oil-engine plants.

Centrifugal Pumps Gain Favor

As late as 1916, substantially all of the pumps in railway service were of the reciprocating type and the remainder were of the positive displacement type, but with the high engine speed of the oil engine and the advent of the electric motor in pumping service, it became possible to utilize the centrifugal pump. However, the pumps of this type that were then available were low in efficiency and not very satisfactory in some other respects. Water-service engineers persisted in their use, however, for they possessed advantages, including direct connection to the power units, or belt drive where direct connection was not practical, or where speeds differing from that of the power unit were desired. Furthermore, the use of the oil engines and electric motors encouraged the further development of centrifugal pumps, and they have now reached so high a stage of perfection that today water-service engineers are almost a unit in favoring centrifugal pumps for pressure pumping, particularly where conditions permit the installation of automatic control.

About 1910, a deep-well turbine was first used for irrigation pumping and soon made its way into the railway field, since it had the advantage of much higher capacity, up to 6,000 gal. per min., and could be used at greater depths than the plunger type. In this type the motor was above ground and the turbine was rotated by means of a pipe or rod extending into the well. About 10 years ago there was a further development of this pump, in which the motor is submerged, being placed below the impellers in a water-tight casing, submarine cables being employed to bring the power to the motor. This type is not limited as to depth since there are no moving parts above the pump, and is the greatest advance so far made in deep-well pumping.

Better Water Storage

Despite its importance, now generally recognized, facilities for the wayside storage of water were neglected for many years. Wayside tanks usually ranged from 20,000 to 50,000 gal., and rarely exceeded 60,000 gal. Although, by 1916, the desirability of greater storage was beginning to be recognized, and not a few roads had begun to install tanks up to 100,000 gal., some of which had been in service for more than a decade, the extension of water treatment was accelerating the movement. When the United States Railroad Administration shortened the hours of service and increased the wages of pumpers in 1918, increased storage became an economic necessity.

Early tanks were of wood, and this material is still used for two-thirds of the 22,000 wayside storage tanks in service today. However, as wood suitable for tank construction became less readily available, or where tanks of large capacity were required, steel began to be substituted, and about one-third of the storage tanks are now of this material, while most of the large treating tanks are also of steel. Owing to the difficulty of keeping the interior surfaces of water tanks painted, steel is particularly subject to corrosion, for which reason there is a disposition on the part of water-service engineers to retain the wood tank when practical to do so, and this has led to a discernible trend in recent years toward the use of creosoted wood in tank construction to increase service life. The latest development in steel-tank construction is the substitution of welded for riveted joints.

Formerly, all water taken by locomotives was delivered directly through a tank spout from a tank located immediately adjacent to the track. Where several tracks were to be served from a single tank, this method of delivery was not feasible and the water column was devised as a solution to the problem. Twenty-five years ago the usual rate of delivery through water columns was about 1,500 g.p.m., and the maximum rate seldom exceeded 2,500 gal. During the last quarter century, improvements in design have involved the valves, the operating mechanism, the flexibility of the spout and clearing of restrictions to flow. Today, the faster schedules for both passenger

and freight trains have created an insistent demand for faster delivery of water to locomotives, and deliveries at the rate of 5,000 g.p.m. are not uncommon, while in a few cases this rate has reached 6,000 gal.

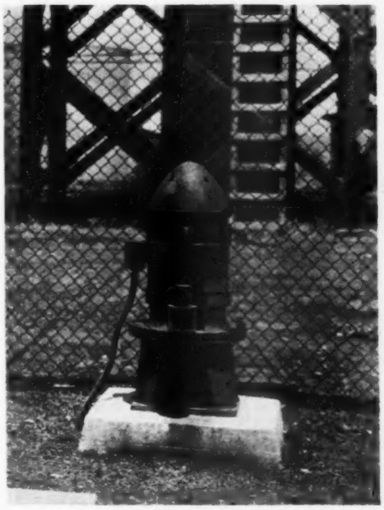
Water Softening Advances

At no time in the past has as much interest been displayed in water treatment as during the last decade, for in this period the number of water-softening plants has increased more rapidly than in any equal period previously; and improvements in equipment and methods have advanced correspondingly. As has been mentioned, 25 years ago there were only 480 water-softening plants in service on the railways, and they were treating less than eight per cent of the water used in locomotives and stationary boilers. By 1927, eleven years later, 1,200 plants were in operation and were treating about 18 per cent of the water used for generating steam. Today, 3,250 water softening plants are treating 38 per cent of all the water consumed.

Although the continuous process was devised in 1900, most of the early plants were of the intermittent type. This method made little headway until equipment for more accurate proportioning of the chemicals became available. In the beginning, the chemicals were mixed in a large tank on the pump-room floor, from which they were pumped by a small steam pump. For the intermittent process, the dosage was gaged by the number of inches of draw-down in the vat. In the continuous method, the pumping was at a constant rate, but as the delivery of the raw water varied, it was not possible to maintain a constant ratio between the delivery of the chemicals and of the raw water.

Remarkable advances have been recorded in the proportioning devices developed since 1916, which now include displacement water motors connected to chemical pumps, venturi tubes, differential flow devices, meter controls for constant and variable feeds, orifices, weirs and tipping meters. Modern proportioning equipment controls the chemical dosage and its rate of delivery within exceedingly narrow limits in correct ratio to the flow of the raw water.

Another outstanding development is that of coagulation and clarification. For many years after-precipitation gave much trouble in pipe lines, injectors and branch pipes. Alum and copperas were employed in some cases to prevent this action. While these chemicals were effective as coagulants, they increased the propensity of the boilers to foam and, in some cases, aggravated pitting and corrosion. One of the real advances in water treatment, more particularly when used in connection with the lime-soda ash process, occurred with the introduction of sodium aluminate. This chemical is a better coagulant than either alum or copperas; it acts as a catylist, in that it accelerates the chemical reactions and forces them to earlier completion; it produces a larger and heavier floc, and reduces the acidity of the water, thus making less soda ash necessary; it makes possible a lower residual hardness than is possible with lime and soda ash alone; and it aids in the clarification of muddy waters.



The Many Developments in Pumping Equipment of Recent Years Have Contributed Largely to the Economy and Dependability of Water Supplies

Interior Treatment

Previous discussion has referred to the exterior method of treatment or pre-treatment, in which the chemical reactions are completed and the objectionable ingredients are removed from the water before it is introduced into the boiler. The interior method came into existence in an effort to avoid the investment necessary to provide facilities for the pre-treatment of locomotive boiler waters. It suffered from two disabilities, however. It was necessary for the enginemen to introduce the chemicals into the locomotive tank whenever water was taken, and failure to do so nullified the benefits that were expected from the treatment. Again, it was not practicable to vary the formula to suit the individual waters on an engine district, so that the full potential benefit which might be derived from the treatment was seldom realized.

To overcome these drawbacks, a simple wayside treating plant was developed about 1926 for the introduction of the chemicals into the raw water as it flows into the storage tank. Plants of this type are entirely automatic, except that the solution tank must be filled with the dissolved chemicals at regular intervals. Where this equipment is installed, the chemical formula can be varied as necessary to meet the requirements of the individual water supplies. The formulas include ingredients that prevent or delay chemical reactions while the water remains cold, but impose no inhibitions as the water is heated in the boiler. This form of treatment, administered with the automatic proportioning equipment, represents a decided advance, compared with the earlier method of introducing the chemicals into the water.

The Threat of the Diesel

Among the most recent of the many developments that are occurring in railway operation is one that may have a profound effect on railway water service. This is the Diesel locomotive which is being used more and more widely for hauling the lightweight streamlined trains that are being operated on such greatly shortened schedules, and is also being employed on some roads for handling certain trains of standard passenger-train equipment. Even more menacing is the fact that within the last three months the same type of locomotive has demonstrated its practicability in freight service with such satisfactory results that already the Atchison, Topeka & Santa Fe; the Denver & Rio Grande Western; the Chicago, Milwaukee, St. Paul & Pacific; the New York, New Haven & Hartford; and the Southern have purchased locomotives of this type for freight service. If this movement should become general, the days of the water station will be numbered.

During the last quarter-century, water service in all of its varied phases has become a far more exact and scientific operation, leaving little to chance in either the quality or the quantity of the water supply. Today water containing less hardness than characterized the treated water of 25 years ago is being softened to a residual hardness as low as 1 gr. per gal. and this is reflected in engine failures, which have been reduced from as frequent as one in 5,000 locomotive miles to one in 10,000,000 locomotive miles. The advances that have been made in the field of water service are so great that the equipment, materials and processes of a quarter century ago have all been rendered obsolete.

25 *Years* DEVELOPMENT IN WORK Equipment

The last quarter of a century has witnessed the development of (or radical improvements in) motor cars — mechanical tie tampers — rail cranes—power wrenches and adzers—power spike pullers and drivers—welding and grinding equipment—off-track ditching and grading equipment—power ballasting and ballast cleaning equipment—weed control—and many other types of power tools and units of equipment

While It Is True That the Motor Car Had Become Recognized as an Essential Piece of Work Equipment by 1916, It Is Equally True That Its Present High State of Development and Universal Acceptance Are Products of the Last 25 Years

NOWHERE in the railway field during the last quarter of a century has there been more marked development than in the mechanization of maintenance of way and structures operations. The word "work equipment," which was a little used word by railway maintenance men 25 years ago, has become the "byword" of these same men today. In the last 25 years, sheer man power has given way to horse power, and the truly "horse and buggy" methods of the first hundred years of railway construction and maintenance have been revolutionized through the use of power tools and equipment in the interest of accomplishing a greater volume of work, increasing the speed of production, raising the quality of work to a higher level, and achieving overall efficiency and economy.

In spite of the great handicaps inherent in adapting equipment to maintenance of way and structures operation, scattered as they are over approximately 274,000 miles of lines in the United States and Canada, in which the equipment must be brought to the work rather than the work to the equipment, many classes of maintenance of way and structures work have reached a degree of mechanization and mass production comparable to the most fully streamlined methods employed in industry generally. As a result, and only as a result, has the "new era" of speed and efficiency in rail transportation been possible, because it is fully recognized by those in a position to know, that motive power can run no faster than the track will permit. In fact, it is true, unquestionably, that without the development that has taken place in mechanical aids, railway track would have throttled in its infancy the new era of train speeds which began less than 10 years ago. With work equipment, in spite of the drastic reductions in allowances for mainteance of way work throughout the depression, the track has kept pace, and, together with modern materials, the means are available today for making the track safe for any passenger or freight train speeds that are desired with properly designed and maintained equipment.

As the availability of power tools and equipment, coupled with modern materials and work organizations, were the salvation of many roads in properly maintaining their properties during the recent depression, so these very same factors may prove the salvation of many roads, if not of our country, in our huge national defense efforts, as experienced men are withdrawn from railway service; as the supply of adequately trained young men to take their places and to meet the needs for enlarged organizations becomes reduced or exhausted

through the call to military training; and as the service demands on the fixed properties of the railways become increasingly large and severe.

The Picture in Retrospect

So short has been the period of work mechanization in the maintenance of way and structures field that there are thousands of maintenance men in the service of the railways today who have witnessed this change almost from its inception. At the same time, there are thousands of other maintenance employees, with shorter service records, who have witnessed relatively little of this outstanding development. Primarily in the interest of this latter group, a brief review of what has taken place is given in this article, although it is unquestionably true that this review will be informative in many details as well to many of those who have worked on the railways continuously throughout the years of this development, but who have, figuratively speaking, "been too close to the trees to see the forest."

Entirely aside from the historical interest in the mechanization of maintenance of way and structures operations during the last quarter century, it is possible that the picture of this development in retrospect will indicate mistakes to be avoided and trends to be followed in mapping out the further progress that must be made in increasing the efficiency, quality and economy of maintenance of way operation, if the railways are to continue to progress and to be in a position to meet the constantly increasing demands for higher speeds, smoother operation, increased safety and reduced operating costs.

Early Progress

To restrict this discussion of work equipment largely to the last quarter of a century, since the publication of the first issue of *Railway Engineering and Maintenance* within its own cover, is not to imply that no units of work equipment were available prior to this period, or that there were not at least a few progressive maintenance men who had a full appreciation of the value of work equipment, and were taking full advantage of the developments up to that time. That this is true, and to an extent greater than is generally realized, is indicated in an article in the first issue of *Maintenance,* in June, 1916, by an assistant engineer on the Baltimore & Ohio, who wrote:

"The character of work coming within the scope of the maintenance of way department ordinarily requires the employment of a large complement of special equipment. For the prompt and economical handling of emergencies, improvement work and maintenance renewals, this is indispensable."

In the same article, it is pointed out that the work equipment on the Baltimore & Ohio at that time included 8 steam pile drivers, 15 steam shovels, 12 steam ditchers, 14 spreaders, 17 unloading plows, 9 Lidgerwood unloaders, 5 ballast plows, 25 rail unloaders, 2 rail-curvers, 3 locomotive cranes, 13 ditching cars, 10 concrete mixers, 10 hoisting engines and 4 air compressors and riveting outfits. This indicates clearly that by 1916, some progressive roads had already sensed the possibilities in work equipment for carrying out maintenance of way operations, but it also indicates two other important facts—first, the limited number of types of equipment that had become established and accepted by this road 25 years ago, including only 14 different types; and second, that all of the equipment enumerated was either steam or mechanically operated, or locomotive propelled.

In this same first issue of *Railway Engineering and Maintenance,* an article by the then chief engineer of the Lehigh Valley indicates unmistakably that this road was also already equipment-minded, and, in fact, was leading the way in the use of certain types of equipment. In June, 1916, according to this article, the Lehigh Valley owned 2 steam shovels, 100 air dump cars, 35 locomotive cranes, 8 light steam derricks and 2 single-end, air-operated hoists. In addition, the author states that, "as fast as practicable, hand cars are being replaced with motor cars for section and extra gangs," pointing out that at that time, the Lehigh Valley owned 182 motor cars, enough for more than 60 per cent of its section gangs. Equally significant is the statement that "pneumatic tie tampers are now being experimented with in large yards equipped with air lines, and seven portable four-tool air tampers are in use with a view to eventually supplanting manual labor for tie tamping operations."

As the foregoing indicates clearly, progress had already been made at the beginning of the last quarter century, and the key to the outstanding development that was to follow, the internal combustion engine, had already become established. However, it is only too evident that up to that time little progress had been made in the development of power tools and work equipment for maintenance of way and structures operations as they are known today, and that the average maintenance officer, schooled largely in securing production with man power, was not prepared, either psychologically or technically to accept the new era of mechanized operations which was opening, without misgivings and a degree of resistance.

Rapid Advances Made

Today, as the result of technological developments, education and the sheer necessity for increased economy, the entire picture has changed, and from the relatively few units of equipment that were available in 1916, there are now more than 125 kinds and types of power tools and units of work

Power Rail-Laying Equipment and the Highly Specialized Organizations for Carrying Out Large-Scale Rail-Laying Operations, Are Entirely Developments of the Last Quarter Century

equipment designed to aid the maintenance of way and structures forces in their work—and that the acceptance of this equipment has become widespread and is still growing is seen in the fact that whereas the units of work equipment purchased annually a quarter of a century ago could be numbered in the hundreds, the railways of the United States and Canada spent a total of more than $20,000,000 for approximately 13,600 units of work equipment in the years 1937 to 1940, inclusive, (the only years for which such information is available) an average of $5,000,000 for approximately 3,400 units in each of these years. Furthermore, according to their own estimates, the railways expect to make record purchases of equipment during the present year, which will involve the buying of more than 5,700 units, at a total cost in excess of $7,700,000.

As the result of this accelerating development, maintenance methods and organizations on the railways have been revolutionized during the last 25 years, bringing about enlarged production, a higher quality of work and marked economies. Costly "pick and shovel" methods, involving large unwieldly gangs of unskilled or semi-skilled labor, are a thing of the past, and while a large amount of what may be classed as unskilled labor is still necessary in carrying out many classes of maintenance work, many operations under the new order have become largely the work of specialists. While most roads still retain the section gang as the basis of their organizations, the size and scope of the work of these gangs has been changed materially on many roads, and large-scale program work is being done today by well-equipped rail-laying gangs, surfacing gangs, ballasting gangs, tie renewal gangs, ditching and bank-widening gangs, steel bridge gangs, and carpenter gangs—all specializing in the operations assigned to them and specially equipped to carry out these operations in the most effective and economical manner.

Motor Cars Led the Way

Unquestionably, the internal combustion engine is the "father" of the modern work equipment used on the railways today, although, for the heaviest operations, steam had been used long before the practical development of the gasoline engine, and continues to be used effectively as the source of power for several types of heavier equipment, especially on-track equipment, such as pile drivers and bridge and wrecking cranes. But, with its large and cumbersome boiler arrangement under almost any conditions, it is evident that the steam plant could not have been adapted to the multiple needs of the maintenance of way and structures forces and that the mechanization of the work of these forces as it is known today had to await the practical development of the gasoline engine.

In the use of this newer form of power on the railways, the motor car led the way. Prior to 1896, railway men had already made crude applications of the small and inefficient gas engines then available to their push and lever cars, and by 1896, the first units known as motor cars, with integrated engines, were available on the market. With this early start and a highly receptive field in view of the recognized advantages of power-operated cars in saving man-hours lost in traveling to and from work and in conserving the energy of the men for productive work on the track, the motor car witnessed marked developments in the next 20 years, although within this period many maintenance men continued attempts to adapt the then available gas engines to their push and lever cars, even at their personal expense in many cases. Therefore, while the use of the motor car was by no means universal by the beginning of the last quarter century, in 1916, it is a fact that by that time it had become established as an essential piece of time and labor-saving equipment for the maintenance of way forces, and was gradually replacing the lever cars of the day on many roads.

This does not mean that by 1916 the motor car had reached its peak of development, for nothing could be further from the fact, as is evidenced by even a cursory examination of the highly developed powerful motor cars of today in comparison with those few models available 25 years ago. It is true, however, that the ground work had already been laid, and that most of the developments of the last 25 years have been refinements in the basic combinations found in motor cars of the preceding period. Among these refinements have been basic changes in the engine units themselves, brought about largely by taking advantage of metallurgical progress and production machinery offered for precision manufacture. This has resulted in greater dependability, increased durability and largely increased horse power, while at the same time retaining the essential elements of simplicity. The growth in horse power is illustrated strikingly in the fact that one manufacturer, without changing the bore and stroke of the engines which it has built during the last 25 years, has been able to increase the horse power developed by its engines for comparable purposes as much as two to three times. For example, in the case of the smaller of the two sizes of engines which it manufactures, the horse power has been increased from three to eight, and in the case of the larger size engines, the increase in horse power has been from 5 to 13.

Other Developments in Cars

In addition to the advanced metallurgy and precision manufacture that have entered into the outstanding developments in engines, there have been the use of ball-bearing and roller-bearing-mounted crankshafts; the use of aluminum alloys in pistons, connecting rods and water jackets in place of cast iron and steel; the improvement in cooling systems; and the outstanding advances that have been made in ignition systems and carburetors, some of these being especially designed and adapted to meet the particular needs of motor car usage and to get maximum power with high fuel economy.

Coupled with these improvements in the power unit have been far-reaching improvements in clutch and belt-drive arrangements to permit free running of the engine, permitting the smooth control of power to the drive axle under varying service conditions with much less effort on the part of the operator than formerly. Incidentally, the belts employed have been greatly improved during the last 25 years, passing from the stage of an impregnated canvas, laced with rawhide thongs, to rubberized canvas with improved steel lacing, and then to the endless cord belts brought out in 1927 on certain cars, with their particularly favorable characteristics of low stretch and high resistance to wear. That there has been marked development in this regard is seen in the fact that whereas belt life in the early days was measured in terms of hundreds of miles, it is today quite common for the belts on inspection and gang cars to give a continuous service life of 50,000 to 75,000 miles.

With these developments have come the demountable steel wheel and the use of precision roller bearings on alloy-steel axles, increasing the load-carrying capacity with an increased factor of safety. Late in the 20's came the use of the structural steel car frame, replacing the wood frame, and subsequently, to reduce weight, frames built of steel alloys have been made available. In the inspection car class, where minimum weight is highly desirable, frames have been constructed of aluminum alloy as far back as 1932, the extruded angles and chan-

nels used in these frames having the strength of steel with but one-third of its weight. A corresponding change has taken place in push car and trailer construction, the all-wood frame of earlier years gradually giving way to the steel frame since about 1930, especially for use where heavy loads of men or materials are to be handled.

Along with these more fundamental features of motor car design and construction have come extension lift handles; more efficient and longer-lasting braking systems; and cabs, the latest types of which provide full front end enclosure with openings for proper ventilation, large areas of shatter-proof glass for clear vision, and rigid, yet light-weight, roof construction, which, with side curtains, provides an inexpensive, yet complete, enclosure against rain, wind and the sun.

And with these developments, a long line of accessories have been made available in the interest of increased safety, greater protection against the elements for those using the cars and the cars themselves, and, in some cases, increased efficiency. Among these are windbreaks, windshields, complete lighting systems for night operation, special gear drives, mufflers, rail sweeps, gongs, turntables, air cleaners, wheel guards, fenders, seat cushions, side seats and rubber cushion wheels. In all, the track motor car of today, in serviceability and adaptability, is as different from the motor car of 25 years ago as is the modern passenger automobile from that of a quarter of a century ago. Furthermore, keeping pace with changes in gang organizations and methods of doing work, motor car manufacturers have developed models, which, in the words of a chief maintenance officer recently, "are so numerous that one can be selected to meet any requirement, from the light, one-man inspection car, to the large car designed for use with large extra gangs and for doing heavy trucking."

Tamping Equipment Almost Entirely New

Second only to the motor car in opening the way for the mechanization of maintenance of way and structures operations was the early development of the gasoline-engine-operated tie tamper compressor, and tamping tools, which first came into the railway picture in 1912. In fact, even more so than the motor car, the pneumatic tie tamper was the immediate forerunner of the widespread application of the internal combustion engine, either directly or indirectly, to maintenance operations, because with it, the door was opened for the development and use of a multiplicity of air-operated tools for speeding up, taking the drudgery out of, and reducing the cost of many items of track and bridge and building work.

The first pneumatic tie tamping outfit was a four-tool machine. Progressively, this single model was expanded into a line which today includes compressor units capable of operating as many as 24 tools, all of these machines incorporating the latest developments in gasoline-engine drive and in air compressors themselves, the most outstanding advance in this latter regard being the development of the two-stage compressor for tie tamping work, in 1933.

As in the case of the earlier models, practically all of the present-day models of pneumatic tie tamper compressors are available with flanged-wheel mountings, although, in keeping with the growing demand of recent years for off-track equipment and for readily portable, small-capacity units for spot tamping, the larger units are now available with crawler mountings for operation entirely independent of the track, and the smaller units are available with rubber-tired mountings, which are moved readily along the track shoulder as the work progresses. At the same time, marked advances have been made in the efficiency of pneumatic tie tamping tools, these tools, operating on the reciprocating piston blow principle, being available today with largely increased efficiency and lower air consumption as compared with earlier models, while at the same time having less weight and better balance in the interest of minimum effort on the part of operators.

From a Start in 1912, a Number of Highly-Efficient Pneumatic, Electric and Unit Tie Tampers Are in Regular Use Today

The first electric tie tamper was used on the steam railways early in 1925, although for a period of nearly five years prior to this date, units with this type of propulsion had been used on electric street and interurban railways where electric power was readily available from over-head trolley wires. To be adapted for use on the steam railways, this first electric tamper, which operates on the vibratory principle, awaited the development of suitable portable electric-generating units, but when these became available more than 15 years ago, first of four- and eight-tamper capacity, it was evident that the electric tamper had become established.

Only a year after the introduction of the vibratory electric tamper, a second electric tamper, operating on the reciprocating-blow principle, was introduced to the maintenance of way forces, this unit employing a piston which is pulled back and forth by two powerful electro magnets, or solenoids. About six years later, or in 1932, when the demand developed for a more powerful tie tamper for use specifically in spot tamping, forcing the ballast under the ties with little or no use of jacks, the power of this latter tamper was materially increased. At the same time, in the case of both types of electric tampers, the initial power generating units have been brought to a high degree of efficiency and dependability, and, with both skid and off-track wheel mountings, have opened the way for the operation of many electrically-driven tools in track and bridge and building work.

Closely related to tie tamping steels or blades of both the pneumatic and electric tampers are the specially designed steels and blades that have been developed for breaking up cemented ballast when skeletonizing track, cleaning ballast or making tie renewals, and other special tools that have been made available for breaking up ice on and about the track and for ditching and drainage operations.

Still another type of tamper that became available to the maintenance forces in 1927, was the self-contained power ballaster, a sizeable on-track unit wherein tamping is accomplished by means of heavy hinged steel tamping shoes attached to the lower part of a heavy cross-head extending across the track for the full length of the ties.

Latest in the tie tamper field was the unit tie tamper, which made its appearance on the railways in 1935. This unit tool, incorporating the gas-engine-drive in the body of the tool itself, and, therefore, being adapted for use separately or in groups of two, four, six, eight, or any number that is deemed desirable, immediately found a place in the railway picture, both because it does not require an independent power plant, and because it lends itself so readily to small-gang operation in spot-tamping work. Since its initial design and operation were based upon the prior use of self-contained gasoline-engine-operated units for drilling rock and breaking concrete, it was evident at once that success would attend the unit tie tamper, which, today, is available in models for both normal surfacing and heavy-duty work.

Highly-Flexible Rail-Laying Cranes, Power Spike Pullers and Modern Power Wrenches Were Unknown to Trackmen 25 Years Ago

Radically New Rail-Laying Equipment

With power tamping a reality, and already being accepted as far back as 20 to 25 years ago, attention was turned to mechanical aids for rail laying, starting a movement in this regard which has since been carried forward to the development of equipment for conducting practically every operation involved in rail-laying work. Twenty-five years ago, rail laying was a series of hand operations throughout. Several roads had employed hand and air-operated rail unloaders and steam locomotive cranes for loading and unloading rail, but the rail unloader was unsuited for setting the rail in the track, and the locomotive crane was not used for this purpose to any extent until 1915. In that year, the tong method, involving 12 to 16 men, gave way on the Lehigh Valley to the locomotive crane, this road leading the way largely as the result of its adoption of its 136-lb. rail section, which made tong work particularly arduous and expensive in view of the large number of men involved.

So obvious were the advantages in the mechanical handling of the rail that other roads were quick to adopt the crane method, and then to seek out lighter and more flexible equipment than the locomotive crane. Evidence of this is seen in the fact that in 1916 the Burlington built a power-operated rail-laying car, equipped with a light revolving boom and a hoist driven by a 30-hp. gasoline engine. This machine was a far cry from later developments, but it very definitely indicated the trend of thought as to the need, and was, unquestionably, the forerunner of the highly developed,

full-revolving, fast-acting light cranes available today for rail-laying work.

In that same year, 1916, indicating further the demand for mechanical rail-handling equipment other than the heavy locomotive crane, a light, manually-operated rail layer was introduced, this being a relatively simple hand-operated chain hoist derrick arrangement operating on one rail, by means of which new rails distributed along the track could be pulled into position and set in place. Filling a need, this machine found a place in rail-laying work, and its acceptance increased with improvements made from year to year. These improvements included equipping it with a gasoline engine hoist in 1924 to eliminate manual crank hoisting, which was a relatively slow and arduous task, especially where the heavier rail sections were involved.

Following these early developments, in rapid order came the development of what is now known as the rail crane. The first of these, coming on the market in 1926, are already obsolete and outmoded in view of the highly flexible and efficient rail cranes available today, which not only meet the need for speed and economy in the handling of rails into the track, but which are also adapted for a wide range of other, relatively light, material-handling operations. Along with the latest developments in these particular machines, all of which are track mounted and self propelled, there has been somewhat of a revival of interest in the readily demountable chain-hoist rail layer introduced in 1916, especially among those roads where labor agreements have materially increased the cost of on-track equipment operation, and where there is increasing difficulty in securing unrestricted use of the track.

Power Wrenches and Adzers

With rail handling being mechanized effectively, attention turned early to the mechanization of the many other operations involved in laying rail. By 1916, taking advantage of the track-mounted air compressors developed for tie tamping, certain roads were already using pneumatic bonding drills, which were later to be greatly simplified and improved. By 1925, a highly practical, self-contained, power-operated rail drill was available, and power-operated gang drills are available today. By 1926, a power-operated rail saw, for cutting rails in the field, was being used by several roads, and by 1928, a pneumatic spike puller had been developed.

Make-shift power wrenches had been built as early as 1915, but it was some years later before fully practicable units became available. Several types of wrenches, both air and engine-operated, were well developed by 1929, but even these models have been largely superseded by highly efficient wrenches, equipped with automatic tension releases, that have become available since 1933, these machines proving as highly effective in the routine tightening of bolts in joint maintenance work as in rail-laying work.

The year 1929 saw the introduction, in the power adzing machine, of one of the most effective rail-laying units available today. This unit, subsequently improved in several respects, relieves many men from the hand adzing of the ties to provide new tie plate seats; avoids the congestion that often occurred in this operation, slowing down rail laying production as a whole; avoids the hazards involved in hand adzing; materially reduces the cost of this necessary operation; and, withal, produces a uniform tie plate seat, which was impossible with hand adzing, eliminating the possibility of damage to newly laid rail because of improper seating.

Spike Pullers and Drivers

Another important power unit being used in rail laying on an increasing scale is the power spike puller, both air and direct engine-operated, the pneumatic type being developed in 1928 and the engine-operated type being put on the market in 1930; the latter has the distinct advantage of being a self-contained unit which, unlike the compressor necessary with the pneumatic puller, is readily removable from the track in emergency. Still another valuable unit of rail laying equipment developed during the last quarter century is the pneumatic spike driver, this unit having been developed in the early twenties and having already found a place in large scale rail-laying operations on several roads by 1927. Today, this unit of equipment, in batteries of from two to eight or more, is found in all of the most highly mechanized rail-laying organizations, speeding up production, eliminating a most arduous hand task, and, under adequate supervision, improving the quality of the work with less possible damage to the rail through misdirected mall blows.

And still other developments during the last quarter century in the interest of better and more economical rail laying, and of importance at least during the periods in which they filled definite needs, were practical tie scoring machines, which preceded the adzing machine and which were an important aid to proper hand adzing, and practical types of power screw spike drivers, both electric and pneumatic, which are still used to large advantage where screw spikes are employed. And so the development goes on in the interest of improved rail laying at reduced costs, the latest units developed being a hooded spraying device for applying creosote to the newly-adzed surfaces of ties, and a power gaging machine which is now being developed and tried out by the Pennsylvania.

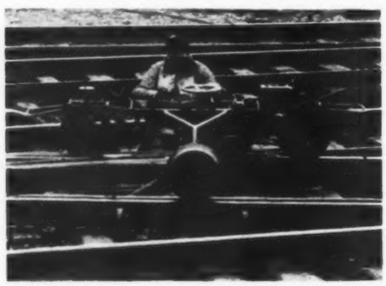
Marked Advances in Welding and Grinding

Closely allied with the developments in equipment for laying rail are the equally important advances that have been made in materials, equipment and technic for repairing rail, frogs, crossings and switch points by welding and

Practically the Entire Field of Track Welding, With Its Large Savings Through Prolonging the Life of Track Materials, Has Opened Up Since the First Issue of *Railway Engineering and Maintenance* in June, 1916

grinding. The oxy-acetylene torch was far from a novelty at the turn of the last quarter century, but it was only at about that time, with the beginning of the practice of building up battered rail ends, that the torch found widespread application in the maintenance of way field. Only a little later, with the development of portable electric generating outfits suitable for use in the field, came the use of electric arc welding for building up rail ends.

Subsequently, the application of welding equipment to maintenance operations was rapid, for the building up of frogs, switches and crossings; the welding of bosses on the gage side of rails, ahead of switch points, to act as switch point protectors; the building up of joint bars to restore lost metal and to compensate for wear under the head of the rail; the flame-hardening of rail ends in track; and flame-straightening of rail joints in track. Keeping pace with these developments, and in some cases anticipating them, the manufacturers of both oxy-acetylene and electric arc welding equipment improved technics, torches, tips, welding rods and generators, taking advantage of the marked advance in welding in industry generally, until today, maintenance men have available to them rods and equipment highly suited to all of their ordinary and special needs, whether for use in the field or in the shop. Possibly the most dramatic application of welding in the maintenance of way field during the last 25 years has been the development of three distinct methods of butt-welding rails into continuous lengths, and the highly specialized equipment which has been developed for carrying out these methods.



Highly Efficient Grinders, with a Wide Range of Mountings for Specific Purposes, Followed Closely the Rapid Adaptation of Welding to Track Work

Many Types of Grinders

Coupled closely with the development of welding has been the development of track grinders. Hand-operated tool grinders, the outgrowth of the whetstone, formed a part of the equipment of many maintenance gangs prior to the turn of the last quarter century, and became generally accepted in the years following 1916, but at that time, except for a few primitive models and home-made devices, the track-work grinder as it is known today was unthought of. In fact, it was not until rail-end welding had become well established and the need for precision finishing became apparent, that grinding equipment especially designed for track work came into the field to any extent.

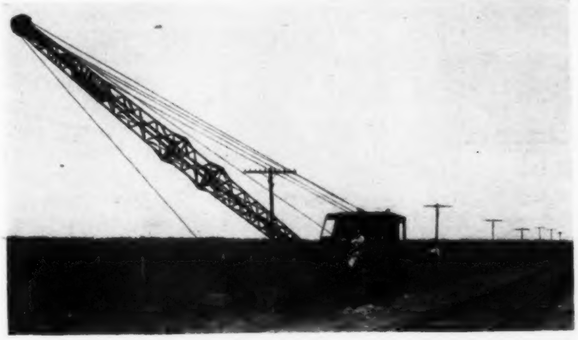
With this relatively late start in the use of grinders in maintenance of way work, grinding operations have become manifold, including the finish grinding of acetylene and arc-welded rail ends; the grinding of overflowed metal from switch points and stock rails; the reshaping of broken switch points; the preliminary and finish grinding of frogs, crossings and switch points built up by welding; the cross grinding or chamfering of rail ends; the removing of humps from rail ends previously hardened; the removing of mill tolerance from rail ends; the equalizing of the height of cropped rails; the removing of rail corrugations; and the longitudinal slotting of the rail head for the insertion of copper strips to prevent the improper functioning of signal circuits at infrequently used turnouts because of the accumulation of rust on the rail.

For these many purposes, the maintenance forces today have available a wide variety of track-mounted and off-track grinding units, of both the hand-held, flexible-shaft type, and the carriage-mounted type. Units are available with both electric and gas-engine drives; with rotary, disc or cup-type grinding wheels, as desired for specific purposes; or of the reciprocating planer type, where the greatest precision in surface grinding is desired. In addition, various of the flexible-shaft-type units are adapted for the operation of a wide range of small power tools, including drills, hammers and concrete vibrators, and a grinder has been developed recently for cropping rail in track or at central points.

Two of the most unusual units of grinding equipment developed in recent years have been the car-mounted grinders developed by the Lehigh Valley and the Pennsylvania for removing corrugations from rail on a large mileage basis. The former, developed in 1934, involves a multiple of fixed grinding blocks which are dragged over the running surface of the rails at 40 to 45 m.p.h., while the latter involves the use of multiple cup-wheel-type grinders which are moved slowly over the rail as a unit in a special train. Equally as important as have been the developments in track-work grinders as to type, capacity and mounting, has been the development in grinding wheels themselves for the various services in which they are used.

Ditching and Grading Equipment

In spite of the fact that earth excavating and moving equipment was considered well developed at the turn of the last quarter century, the changes in this type of equipment have been almost as revolutionary as in any other type of equipment employed by the construction and maintenance forces of the railway. These changes have come about largely through the developments in the gasoline and Diesel engine and the increasing demand for larger-capacity, greater flexibility and increased economy of operation, and, in more recent years, for crawler-mounted units that can be operated entirely independent of the track. It has also come about in part by a change in the character of the work to be done, this turning more and more to the maintenance of the existing properties of the railways and



While Earth-Moving Equipment Was Considered Well Developed by the Turn of the Last Quarter Century, the Changes in This Type of Equipment Have Been Almost as Revolutionary as in Any Other Type of Equipment Employed by the Construction and Maintenance Forces

away from the heavy grading operations of line construction, which, when encountered today, are handled almost invariably by contractors especially equipped for the tasks involved.

The modern ditcher spreader, with greater weight, length, strength, wing spread and flexibility, with special attachments for a multiplicity of operations in moving and spreading earth, ballast and snow, as well as for shaping cuts and shoulders, incorporates many improvements over the home-made spreaders of earlier years, and over even the commercial models available 15 to 25 years ago. Likewise, the modern ditcher, now flange-wheel or crawler-mounted as desired for different methods of ditching, and the modern crane, in a wide variety of models and capacities, gasoline-engine, Diesel-engine or electric-motor-driven, and with crawler mountings if desired, are in marked contrast with their more cumbersome inflexible predecessors of only a generation ago.

Furthermore, unthought of in this earlier period are the combination shovel-dragline-crane units of recent years, with crawler mountings for operation either from the ground or flat cars; the latest improvements in large-capacity air-dump cars; and the modern, highly versatile crawler tractor with its many attachments and auxiliary units for excavating, spreading, hauling and compacting material, including the bulldozer, the angle dozer, the front-end loader, the scraper, the carryall, the rooter and the sheepsfoot roller. Through these developments, ditching, trenching, snow removal and general grading operations have been revolutionized on many roads, reducing costs, minimizing interference with train operation, improving the quality of the work in many cases, and, in addition, permitting the carrying out of many classes of work for which earlier equipment was lacking or was not at all suited.

Ballasting and Ballast Cleaning

Equally striking are the marked advances that have been made in equipment for working and cleaning ballast, especially stone ballast, work of this character being a fork or fork and screen operation almost entirely as recently as 15 years ago, or totally neglected because of the arduous character of the work or the inability to carry out appreciable programs because of the size of the forces and large costs involved. In dire need of a more prolific and economical means of cleaning ballast to eliminate pumping track in summer and heaving track in winter, with largely increased general maintenance costs, a couple of roads, as early as 1922, had turned to the use of their locomotive cranes and clamshell buckets in conjunction with stationary or vibrating screens mounted on gondola cars, and several roads were experimenting with simple conveyor-type units, one requiring the hand shoveling of the old ballast on to a belt conveyor leading to a revolving screen, and another attempting, quite unsuccessfully, the use of a bucket conveyor arrangement.

The crane and clamshell method proved quite successful and showed large volume production over hand methods. It also showed considerable economy, especially when the cranes were employed in batteries of three or more to reduce work-train costs per lineal foot of track cleaned. At the same time, it largely solved the problem of a shortage of labor for this kind of work in these years, but it had the disadvantage of tying up these many-purpose machines at a season when they were much needed for other classes of work.

First Successful Machine in 1926

It was not until 1926 that the first successful, relatively small, self-contained ballast-cleaning machine became available, first exclusively for cleaning the ballast in the inter-track space, and subsequently, adapted for shoulder work. Individually, these machines had far less capacity per day than the multiple-crane and clamshell arrangement, but they showed large savings per track foot of ballast cleaned over hand methods and eliminated all manual work, except a small amount of guiding of the edge ballast into the path of the conveyor pickup, and the carrying away, in boxes, of the dirt removed. Subsequently, these machines were equipped with belt conveyors to carry the dirt to the edge of the track shoulder, eliminating hand labor for this part of the work. In view of these advantages, and the further advantage that they work entirely in the clear of traffic, these machines have received wide acceptance, and, further improved and strengthened in recent years, form the backbone of ballast cleaning methods on many roads at the present time.

However, seeking greater produc-

tion per unit and still lower costs, if possible, attempts were made to produce car-mounted, large-capacity ballast cleaners, employing grab buckets or drag-scoop arrangements leading to conveyors and shaking screens above, the dirt removed being conveyed to the track shoulder or to trailing hopper cars coupled with the equipment, while the cleaned stone is returned to the roadbed. Two of these types of machines proved successful, although only a few units are in service, and one of the types is now being further improved substantially through the introduction of chain-bucket conveyors in place of grab buckets. With these machines and the small, self-contained ballast cleaning machines, ballast cleaning today is being measured in hundreds of track miles per year, on single roads alone, instead of in thousands of feet, in patches, as was common 25 years ago, if the work was undertaken at all, and at only a fraction of the expense involved in hand methods.

Along with these developments, two roads have developed and used track sweepers, one of them having also developed a large car-mounted vacuum-type machine, both of these machines being designed for use in territories of heavy grades to remove periodically the rapid accumulations of cinders and stack ash on the track, and thereby prevent it from working down into and fouling the ballast.

Many attempts have been made to develop a track skeletonizing, or cribbing machine, but it was not until 1934 that a fully successful machine was available. Even this machine, which kicks the ballast from the cribs to both sides of the track, has not come into widespread use except on a few roads, the belief prevailing among many maintenance of way men that crib cleaning is of secondary importance to shoulder and inter-track cleaning, and that the limited amount of money that becomes available for ballast cleaning work should be spent on shoulder and inter-track ballast cleaning first.

Closely allied with the developments in ballast cleaners have been those in track ballasting equipment, including cars for the hauling and even distribution of the ballast; the power track jack, developed from the power track shifter, and first put on the market in 1929; the power track ballaster, especially effective in making first raises, which came out in 1927; and, of course, the various types of power tie tampers for making the final running surface. All of this equipment has contributed to speed and economy in ballasting work, with the elimination of arduous hand labor; one road, for example, as early as 1930, engaged in a large stone ballasting program, having improved its performance through the enlarged use of the equipment then available, from less than 2,000 track feet a day to more than 3,000 ft. a day, with practically the same size forces.

Many Developments in Weed Control

Keeping the ballast free of weeds has been a problem for the railways from the beginning, but up to 1916 the principal methods of attack were still hand pulling, the shovel and the scuffle hoe, although as early as the turn of the century, poisonous chemicals had been introduced for killing vegetation in the track and several roads were employing discing and weed-mowing attachments on motor cars to destroy shoulder growth. These methods were effective, but, by present standards, relatively inefficient, and it was not until the beginning of the last quarter century, with the labor shortages created by the first World War and a fuller realization of the disadvantages of a weedy track structure in fouling the ballast, hastening the decay of the crossties and causing driver slip, that the real developments in weed control and destroying equipment started. From then on, these developments came fast, employing live steam, burning equipment, ballast discers and scarifiers, and improved chemicals and methods of application.

Indicative of this advance is the fact that discers available today can accomplish more work per hour than was possible with the first discing machines available in three days' time. On-track weed burners have not only been greatly improved in effectiveness and economy of operation, but are now available in an off-track unit and in models that will burn at the rate of six to seven miles an hour, and to a width of 23 ft. each side of the center line of single track. Likewise, on-track weed mowers are now available that are quickly adjustable and that will cut on each side of the track for distances up to 29 ft.

As for chemical weed-killing methods, these have seen marked developments, both in the chemicals employed, which are now available in both liquid and powder form, and in both poisonous and non-poisonous types; and in the equipment available for applying the chemicals, which ranges from knap-sack kits to car-mounted equipment that will spray as much as three adjacent tracks at a time. The most recent developments in weed control equipment have been in off-track weed mowers of the wheeled-tractor type, designed for shoulder and right-of-way mowing, a number of different types of these machines now being available and gaining increased acceptance.

Many Other Developments

And so the developments in equipment have taken place during the last 25 years, reaching into almost every phase of railway construction and maintenance work, some of them being exclusively for railway application, while others, such as the motor truck, which is finding increasing use by the maintenance forces, have been adapted from industrial life generally. Among the other developments in tools and equipment that deserve mention are snow-fighting equipment, especially the developments in oil, electric and gas switch heaters or snow melters; portable floodlighting equipment of both the gas and electric types for night and emergency work; track

In Spite of Many Attempts, It Was Not Until 1926 That the First Successful, Self-Contained Ballast Cleaning Machine Became Available

A Wide Variety of Pneumatic, Electric and Direct Engine-Driven Portable Tools Has Been the Outstanding Development in the Equipment of the Bridge and Building Forces in Recent Years

liners, to permit this class of work by the small section gang; the tie saw, which is showing marked economy in tie renewal operations, especially when used with specially organized tie gangs; the tie-bed shaper, which is designed to permit tie renewals with minimum disturbance of the tie bed; mechanical tie pullers, now becoming available in several different types in an attempt to meet the urgent desire for mechanical aids in tie renewal operations, both by section and extra-gang forces; earth augurs for digging post and pile holes; and the tie nipper, a device to economize in labor while spiking.

To a no less important extent, these developments have extended to practically every hand tool used by the maintenance forces, even though many of them, as the result of the development of power tools, are used less intensively than heretofore. Thus, for example, even such basic tools as the track shovel, the rail chisel and the claw bar have undergone important changes in design, quality of materials used, and methods of manufacture. Furthermore, and especially important in view of the refinements that are being called for in all classes of maintenance work, marked improvements have been made in such essential units as steel and metallic measuring tapes, the latest development in the former being tapes with a satin chrome-white background and jet-black markings, which are more accurate, legible, durable and rust resistant than anything that has been available in the past.

Increased Equipment for B. & B. Forces

In the bridge and building field, the developments in mechanical aids have been equally as important as in the track field, and, except for a few basic heavy-duty machines which were well established in this field prior to the last quarter century, such as the crane, derrick, wrecker, pile driver and concrete mixer, all of which have undergone marked changes in the last 25 years, the developments have been more concentrated in recent years than in the track field. Among these developments have been structural and pipe cutting and welding equip-

Mechanical Tie Pullers Are Now Becoming Available in Several Different Types

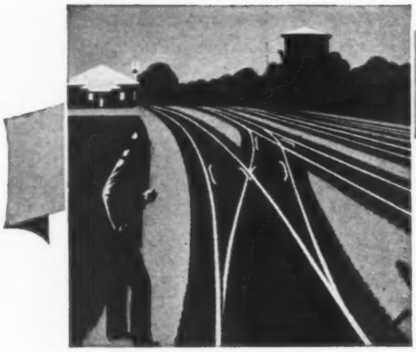
ment; spray painting equipment; air and electric hoists; woodworking machinery; flame descaling, dehydrating and paint removal equipment; and a wide variety of portable pneumatic and electric-driven power tools such as drills, wood borers, wrenches, reamers, chipping, scaling and calking hammers, sanders, rotary brushes; and saws; much of this latter equipment finding its way into bridge and building work only within the last few years with the further development of highly efficient, portable, power generating plants.

Even in the case of the jack, known in various forms to track and bridge men since the early days of railroading, there have been many developments and refinements, these including increases in capacities up to 250 tons and more, and quicker and more positive action; some types being equipped with manual or automatic lowering features, while others are adapted for carrying out several operations, such as spacing ties, pulling bridge spikes and bolts, and for a wide variety of other operations.

The Future

And so, to an extent little realized by even those long engaged in railway construction and maintenance work, the progress in the mechanization of methods and operations has gone forward at an accelerated pace, the result of the foresight and ingenuity of both railway and railway supply men, working independently and in co-operation. In some respects, progress in development appears to have outdistanced the demand, as many roads still have a long way to go in the effective mechanization of their forces, in spite of the clearly demonstrated advantages of such mechanization on other roads. At the same time, there is still need for further developments in equipment to meet the changing needs of railway forces, for present work equipment and power tools will, unquestionably, appear as out-moded in appearance, adaptability, production and efficiency at the end of the next quarter century as do today those units that were available a quarter of a century ago.

The Tie Saw, a Development of Only the Last Three Years, Is Showing Marked Economies in Large-Scale Tie Renewal Operations



WHAT'S the Answer?

Adherence to Rail Laying Standards

What is the best means of insuring adherence to adopted standards when laying rail? How should this be done? Why?

Co-operation Necessary

By W. H. Sparks

General Inspector of Track, Chesapeake & Ohio, Russell, Ky.

This is an important question, because the adherence to rail laying standards in the laying of new or relay rail means much in future reduced track maintenance. Of course, there is only one answer to this question—co-operation. Co-operation must exist between the supervisors and the gang foremen and also between the foremen and the men of the gang, if the work is to be done uniformly to the standard required.

In the first place, before the work is begun, the supervisor should go over it with the extra gang or rail laying gang foreman and make available to him the standards and blue prints pertaining to rail laying work. The gang foreman must then select men in his organization to be responsible for each operation and see to it that they understand the standard required in that operation. The men desire to do the work in the manner in which it should be done, but all too frequently they are not definitely instructed in exactly what is wanted.

The next most important thing is to have all material so distributed that it can be used quickly and conveniently without interference with other operations. So far as possible, all material should be on hand and unloaded at the place where it is to be used, for if any material is lacking, the gang will be slowed up or stopped, or the work will be done in a manner not in accordance with the standards, in order to keep the gang busy and not delay the progress of the work.

Occasionally, work is done which is not in accordance with the standard required. One should never criticize a good foreman for such work until he has investigated and ascertained the reason for the deviation. Sometimes such changes from standard are improvements that are worth while, and it is also true that in special circumstances; the standards which are set up do not always work out.

Requires Good Supervision

By A. E. Perlman

Chief Engineer, Denver & Rio Grande Western, Denver, Colo.

The best means of assuring adherence to standards in rail laying work is to provide excellent supervision of the work by men who are capable of understanding the adopted standards and realize the importance of adhering to them. Blue prints and instructions should be furnished the foremen and assistant foremen in charge of the rail laying gangs and these instructions should be set forth in a clear and concise manner that is readily understandable. Furthermore, the gangs should be provided with sufficient men, physically fit to do the work, and careful preparation for and planning of the work should be done to eliminate confusion and delay. Such preparation should include the proper distribution of all track materials far enough in advance of the rail laying gangs to avoid interference with the performance of the rail laying work.

Send your answers to any of the questions to the What's the Answer Editor. He will welcome also any questions you wish to have discussed.

To Be Answered in August

1. *What are the advantages and disadvantages of track-apprentice or student-foreman training systems? What qualifications should be given weight in selecting candidates?*
2. *What stock of emergency materials should be carried for repairs to a mechanical coaling plant? Where should they be kept?*
3. *How many men are required in a fully mechanized rail gang? How should they be organized? How many units of equipment should be provided?*
4. *What are the relative advantages of bridge piers constructed of metal bearing piles, metal sheet piling and piers of concrete masonry?*
5. *Can surfacing out-of-face be performed safely without slow orders? If so, under what circumstances and how high a lift? If not, what is the maximum speed recommended? Is flag protection necessary?*
6. *Under what conditions is it desirable to install automatic control of pumping? Is this type of control feasible with internal combustion engines?*
7. *What is the best way to line a main line turnout in well-ballasted track laid with heavy rail? How many men are needed? What tools? What precautions may be necessary?*
8. *Is creosoted material suitable for use in enginehouses? If not, why? If so, to what extent? What are the advantages?*

It is important that standards be established for laying rail in order to insure a uniform manner of doing the work on an entire system, and, if such standards are adhered to, a better job will be obtained and the life of the rail will be prolonged. In addition, the unnecessary expense of regaging, resetting tie plates and readjusting rail anchors will be largely eliminated.

Planning Important

By W. L. Roller

Division Engineer, Chesapeake & Ohio, Columbus, Ohio

Systematic advance planning, efficient and careful distribution of materials, the organization of an adequate, well equipped force and the fixing of responsibility for each operation and item of work, are necessary to insure the complete adherence to standards and practices in rail laying work. The work of laying rails in either single or multiple main tracks, consists of three distinct phases: (1) preliminary and preparatory, (2) the actual laying of the rail, and (3) the loading and classification of the released rail and fastenings.

The preparatory work, while less hurried, is as vital to the proper laying of rail as the later phases. The preparatory work consists of the advance preparation of the track and the unloading and distribution of the new material. If mechanical adzers are to be used, the ballast under the rail must be lowered below the tops of the ties. New rail and fastenings should be unloaded and placed in a manner to make them readily accessible when actual rail laying begins and to permit the performance of other items of preparatory work. For example, we have discovered that it is quite advantageous in multiple track territory to unload the rails in the inter-track space, setting them up workwise at a slight angle, with the forward end inclined toward the track in the normal direction of operation, lapping the rails by each other one-half length. This position permits the easy application of oil and angle bars in advance of the rail laying operation.

We have also found that the unloading is greatly expedited by loading the new rails at the steel mills in single layers workwise, with strips of wood between. The proper unloading of rails and switch materials enables the rail laying forces to do their work in accord with standard practice and with a minimum of delay. A judicious distribution of short rails at signal locations and other points may greatly reduce and sometimes eliminate the necessity for cutting rails, which will not only reduce waste and delay but also prevent the use of rails which are sometimes too short for practical use.

The second phase, the actual relaying work, may be roughly divided into three groups of operations: (1) the removal of the old rail, the clearing of ties of spike stubs, etc., the plugging of the old spike holes and the adzing of the ties; (2) the application of tie plates, rail and joint bars, and the full bolting of the joints; and (3) the gaging and spiking of the new rail to proper line, and checking to see that all plates are properly placed. The forces should be so organized as to fix the responsibility and supervision for each of these operations. In gaging the first rail through, it is well to make sure that the irregularities or inequalities of the line and gage of the old rail are not reflected in the new. This can be done by not applying the gage at the old joint locations.

The third phase, the loading and classification of the released rail and fastenings, is the least interesting, but none the less important, so far as adherence to standards is concerned. The proper classification, salvaging and loading of the released materials in the field is important because it may greatly reduce the rehandling required at the reclamation point.

Placing Struts in Culvert Pipe

What advantages are there in placing struts in culvert pipe when it is being installed? What disadvantages? How should they be placed? How long should they be allowed to remain?

Precautions Necessary

By E. C. Neville

Bridge and Building Master, Canadian National, Toronto, Ont.

This question evidently has reference to flexible culvert pipe, such as corrugated iron pipe, rather than concrete or cast iron pipe, which are usually classified as rigid types. Certain precautions are necessary in installing the larger sizes of corrugated pipe, say 48 in. in diameter or larger, that are not as necessary for the smaller sizes. Careful backfilling around the pipe is required to give the sides proper support and retain an even diameter, both vertically and horizontally. Large diameter pipe will deflect when the full load of the fill is in place over it, and, unless the backfilling is thoroughly tamped around the sides for at least three-fourths of the circumference, the culvert will not retain the shape of a true circle.

This condition can be overcome, however, by placing struts inside the pipe. The struts should be of sufficient length to distort the pipe slightly so that the vertical diameter is about 3 in. greater than the horizontal diameter. They should be made of 4-in. by 4-in. timbers, spaced about 6 ft. apart for fills up to 20 ft. in height, and with reduced spacing for fills of greater heights. A single 4-in. by 4-in. sill for the struts should be laid along the bottom of the pipe and two 4-in. by 4-in. caps should be placed side by side at the top, with a short cross cap or block placed between the double caps and the top of the vertical struts.

Two screw jacks may be used when placing the struts to obtain the pipe distortion necessary. These are set on the bottom sill at one end of the pipe, spaced as far apart as the strut spacing. After the first strut is placed, the nearest jack is released and moved forward to the position of strut No. 3, and in this manner the jacks are moved alternately through the length of the pipe, placing one strut at a time, after which the filling can be carried on.

The struts should be allowed to remain a sufficient time for the fill to settle, but if it should be necessary to clear the culvert for a full flow of water, they can be removed easily with a few blows of a sledge hammer. As the struts are released, the weight of the fill on the top of the pipe forces the sides firmly into the back filling, thus increasing the stability of the culvert and restoring the pipe to its original shape. In all culvert pipe installations, care should be taken to provide a good even foundation bed and to see that the back filling is well tamped under the haunches.

Use in Corrugated Pipe

By G. A. Haggander

Assistant Chief Engineer, Chicago, Burlington & Quincy, Chicago

Our general practice is to install struts only in corrugated iron pipe. When the height of the fill in which a pipe is to be installed is great, and the expected pressure is such that the pipe may be distorted unduly, the ver-

tical diameter is increased by jacking or by fabrication and struts are placed. For this purpose, we use second-hand 8-in. by 8-in. fir bridge ties for the struts, caps and sills. The struts are placed vertically, approximately 3 ft. apart. We find that under heavy pressure, the caps crush in a way that the pipe itself is not distorted locally.

The disadvantage of struts, of course, is that they catch drift and this must be watched until they are removed. The length of time that struts are allowed to remain depends upon the amount of trouble experienced with drift. Where this is a serious problem, the struts are removed after about one year, during which period the fill has taken its largest settlement. Where drift is not a problem, we leave the struts in place until they are practically decayed.

est lift that will accomplish this is best, as such a lift uses a minimum of new ballast and a minimum of labor.

How High a Lift in Surfacing?

What conditions justify high lifts when surfacing track? What limitation, if any, should be made? Why?

Depends on Conditions

By C. E. Miller

Assistant Engineer of Maintenance, Chicago & North Western, Chicago

This question is related to the proper depth of ballast and good drainage. It also refers to special conditions which might bring about the necessity for a considerable lift over the depth of ballast already existing.

The ballast section should be of sufficient depth to distribute its load uniformly to the subgrade at a pressure within the carrying capacity of the soil, and a high lift may be necessary to obtain this condition. If the ballast section is not of sufficient depth to provide a uniformly distributed load on the subgrade at a pressure within its carrying capacity, settlement of the track will result, and depressions will form under the ties, which will retain water and cause muddy ballast and churning ties. Yielding soils in the subgrade should first be provided with a mat of cinders or other permeable material, which should be mixed with the sub-soil before the final lift is made on good ballast.

Before ballast is applied, the subgrade should be prepared to secure good drainage, and the banks should be widened to a sufficient width to retain it. Otherwise, it will be wasted down the embankment and end support for the ties will be lost. Improperly drained subsoil or foul ballast may result in heaving in winter, with rough roadbed, increased rail stresses, and heavy maintenance expense for the required shimming. This should be corrected, so far as possible, by subdrainage and by a sufficient lift of ballast over a sub-ballast such as clean sand or cinders, extending below the frost line.

If a raise of more than about 6 in. is required, I would make it in more than one lift, as the proper compaction of the ballast cannot be obtained in a single lift of greater depth. High lifts may be necessary at certain locations to improve local grade conditions, take out objectionable sags in the grade line of the track, get the track above adjacent water conditions, or to prepare the line for heavier power, all of which generally involve other problems than ballast.

High Lift Seldom Justified

By G. S. Crites

Division Engineer, Baltimore & Ohio, Punxsutawney, Pa.

Real high lifts are seldom justified. Occasionally in isolated locations a deeper mat of ballast is needed to distribute the load onto a poor carrying sub-grade, and in such places a high lift on fresh ballast transforms the old ballast into a mat or sub-ballast, and thereby strengthens the subgrade. In such cases, lifts up to 12 in. might be justified. Also, in long, narrow cuts, it is sometimes advantageous to give the track a high lift to widen the track section and provide an adequate width of roadbed. If the sides of a cut have a 1-to-1 slope, a 1-ft. lift of the track provides a gain of 2 ft. in the roadbed width, and often ample side ditches can be obtained in this manner.

Other than for the above conditions, or for similar exceptional cases, high lifts are not justified. They are expensive and cause more damage than good. The berms must be built up with the track, or else the track will be on a pinnacle, and the ballast will roll down the banks.

Generally the limitations for a surfacing lift are governed by the condition and character of the ballast. The purpose of the surfacing is to level up the track and give the ties a uniformly cushioned bearing. The light-

Two or Three Inches Ample

By M. B. Davis

Track Supervisor, Illinois Central, Kankakee, Ill.

High lifts when surfacing track are justified only when special or unusual conditions exist, otherwise they are objectionable, for they result in additional expense for widening banks to provide proper support for the track structure, and reduced clearance on overhead structures. Usually a two to three-inch lift on clean, hard ballast will prove ample. Such a lift provides sufficient space under the ties to permit a good job of tamping to be done.

Track subjected to extremely heavy tonnage will require a somewhat higher than average lift in order to realize reasonable benefit from the surfacing operation. New, unstabilized roadbed likewise should receive a high lift. Stripped track in the process of reballasting or surfacing on light ballast, such as cinders, usually needs a higher than average lift. Other conditions calling for a high lift are subsidence on high fills and pulling out sags to improve the general grade line of the track.

Favors Minimum Lift

By W. H. Sparks

General Inspector of Track, Chesapeake & Ohio, Russell, Ky.

The principal purpose of a surface out of face on new ballast is usually to obtain a new cushion of clean ballast under the ties and to maintain a good track drainage condition. In former years, before ballast cleaning machinery was developed and used extensively, ballast had to be cleaned by hand when it became fouled, or the alternative was to work the old ballast at the ends of the ties out on the subgrade shoulder and make a high lift on new ballast. Cleaning ballast by hand was slow and expensive and the latter alternative was resorted to extensively in order that the required amount of track, as expected by the officers in charge, could be improved each year.

While not all railroads handle their track work in the same manner, and while the various types of ballast in use and the kind and amount of traffic are factors which determine the care exercised on each railroad in maintaining the existing ballast in the

track, today, with machinery available for cleaning ballast, the conditions that formerly justified a high lift do not obtain, and there are few reasons, except in special circumstances, for making a high lift.

Where the ballast has been cleaned, I favor a minimum lift of 1½ to 2½ inches. Such a lift, with machine or pick tamping, is high enough to permit ties to be well tamped uniformly across the entire width under the tie. A lift that is too high will only cause trouble, because the settlement under traffic will be uneven and the track must be smoothed up again afterward. If shovel or fork tamping is used, a somewhat higher lift should be made than for machine or pick tamping to enable the tampers to fill the space under the ties uniformly and to allow for a greater settlement of the surfaced track under taffic. A comparable maximum lift and additional allowance for the types of tamping employed, are recommended for cinder or gravel ballast. When a track ballasted with cinders, sand or gravel, is reballasted with any hard crushed ballast, such as crushed rock or slag, at least an inch must be added to the height of lift, to allow for the additional settlement of the relatively hard ballast into the softer bed under the ties. This settlement will be particularly noticeable on lines of heavy traffic.

As I see it, unless there are sags in the surface of the track, a high lift is a thing of the past, and there is no longer need for it. A further factor which makes the high lift more or less obsolete, so far as the regular track maintenance forces are concerned, is that of safety. In these days of fast passenger and freight train speeds, high lifts cannot be made without flag protection during the period when the work is being done, and later slow order protection until settlement of the newly surfaced track has taken place under traffic.

Should Be A Limitation

By L. A. McLeskey

Section Foreman, Illinois Central, Leedy, Miss.

I can think of only two conditions that justify a high lift in surfacing track: (1) when changing from one type to a better grade or type of ballast, in which case experience has shown that better results at lower cost are realized by making a lift high enough to establish a substantial bed of the new ballast under the ties; and (2) when there are dips or sags in which the track has been allowed to settle below grade, particularly at locations where soft spots have been cured.

On a well-established roadbed, the lift should only be high enough to permit about two inches of clean ballast to be tamped under the ties, which will provide good drainage and smooth riding track. I find that good results are never obtained with a raise higher than six inches on any kind of ballast and a six inch lift is not always satisfactory when done under traffic. A lift of six inches or more also slows up the progress of the gang, as it takes longer to fill the space under the ties and longer to refill the ballast cribs. If it is necessary to lift the track more than six inches, it should be done in more than one lift, with the final lift never more than three inches.

There should be a limit to the height of lift allowed, because the settlement of the track with high lifts is frequently very irregular, resulting in swinging track, side thrusts, bent rails and generally rough riding conditions.

What Records of Building Repairs?

Should records be kept of the repairs to individual buildings? In what detail? Who should keep them? For what purpose can they be used?

Records Should Be Kept

By Frank R. Judd

Engineer of Buildings, Illinois Central, Chicago

A record of physical repairs to buildings should be, and undoubtedly is, kept by most supervisors of bridges and buildings or master carpenters for their own information as well as for annual reports. In addition to the physical record of repairs, some financial or cost record should be kept as well by the responsible officer in charge of the work, providing information, quickly accessible, on what has been done over a course of years in the maintenance of a structure or structures. Such a record should not be complicated or require too much time and office work.

The following is a suggested form or record to be kept by the division supervisor of bridges and buildings, master carpenter, or others directly responsible for the maintenance of buildings:

Record of Repairs or Improvements

Location ....

Division ....

Name or number of building..........................

	Date	Description	Cost
Foundation repairs	....	....	....
General carpentry repairs	....	....	....
Floor and stair repairs	....	....	....
General masonry repairs	....	....	....
Glass renewed	....	....	....
Painting (exterior)	....	....	....
Painting (interior)	....	....	....
Roof repairs	....	....	....
Roof renewed	....	....	....
Plumbing repairs	....	....	....
Plumbing renewed	....	....	....
Heating repairs	....	....	....
Heating plant renewed	....	....	....
Electric light, wiring and fixture repairs	....	....	....
Electric lighting, wiring and fixtures renewed	....	....	....
Other repairs or renewals	....	....	....

Several copies of this report can be made, and on railroads which prepare annual budgets for building repairs and improvements, it would be advisable to send a copy of the foregoing report to the officers in charge of budget matters.

Not for Minor Repairs

By V. E. Engman

Chief Carpenter, Chicago, Milwaukee, St. Paul & Pacific, Savanna, Ill.

A record in some form is kept on most railroads, showing the original construction of buildings, giving the year built, size, kinds of materials in the various parts and the manufacturer's reference for special materials, machinery, plumbing, heating plants and appurtenances. To this original record, all major improvements, additions, alterations and renewals are added. I do not consider it necessary to keep a record of the many minor repairs that are made from time to time. This would involve considerable work which would serve no useful purpose. An exception to this rule would be made for repairs made for test purposes to obtain a comparison between materials or appliances. The records of such tests should be kept in the division offices.

It is important to have a complete original record of each building, how-

ever, for reference when it becomes necessary to obtain replacements or repair parts. Usually a building does not need major repairs or replacements for a number of years after it has been constructed, and when replacements or parts are needed, difficulty may be encountered in obtaining the right material or repair parts needed unless a record of the materials used and their manufacturing source is readily available.

What Type of Cast-Iron Pipe?

What are the relative advantages of flanged and bell and spigot cast-iron pipe? The disadvantages? For what purposes are each best adapted?

Each Has Its Field

By J. P. Hanley

Water Service Inspector, Illinois Central, Chicago

Flanged cast iron is usually used above ground and in tunnels or pipe galleries, where the joint is accessible. Bell and spigot pipe, on the other hand, is generally used in buried positions, either underground, under water, or where conditions may cause some settlement. Because of the rigidity of the flanged joint, it may break under stress caused by settling, if laid in trench bottoms. The bolts in the flanges also constitute a relatively weak condition when installed in inaccessible locations under paving, buildings and other structures, since they deteriorate before the cast-iron and have a limited life, compared with the lead joint in bell and spigot pipe, in which case the life of jointing material is greater than that of the pipe.

Flanged cast-iron pipe is useful in certain locations around power houses, filter plants and industrial concerns where abrasion, acid or moisture conditions will not permit the economical use of wrought iron or steel flanged pipe and where a thick-walled cast-iron pipe with convenient joints is desirable. However, the joints are usually visible or accessible and are well supported to prevent settlement.

It is questionable if more than one per cent of the total cast-iron pipe tonnage sold is made with flanged joints. The bell and spigot joint with lead or with a good substitute jointing material appears to be used in the vast majority of installations.

Depends on Conditions

By K. J. Weir

Special Water Inspector, Chicago, Milwaukee, St. Paul & Pacific, Chicago

In general, flanged cast-iron pipe is best adapted for use above ground, being particularly desirable in locations where space is limited and for high pressure pipe lines. Another advantage of flanged pipe is that it can be dismantled and re-assembled readily for repairs or changes. The original installation of flanged pipe must be carefully planned, however, and the pipe must be ordered to exact dimensions to insure proper assembly, but when completed, it presents a compact, neat installation. The principal disadvantages of flanged pipe lines are their rigidity and tendency toward breakage under excessive vibration or settlement, and the rapid deterioration of bolts and nuts in certain types of soils encountered in underground pipe lines.

Bell and spigot pipe is more suitable for underground installations, as it can be laid with an uneven grade or alinement; it has permanent, durable joints and, if proper joint materials are used, is flexible enough to withstand reasonable amounts of settlement and vibration. Changes that may be found necessary while installing a pipe line can be made much more easily with bell and spigot pipe than with flanged pipe. Joints in bell and spigot pipe, cannot, however, be properly completed in cramped quarters, and high pressures, surges or water hammer may blow them out, but this hazard can be reduced materially by the application of special collars or anchors on the finished joints.

A proper design of piping systems when they are originally installed cannot be over-emphasized. The best installation may be a combination of the two types or may use some of the more recently developed pipe-joining materials. Maintenance of the system should be carefully considered when the design and installation are made.

Should Rail-Ends Be Inspected?

When renewing joint bars or removing them for other reasons, should the rail ends be inspected for incipient bolt-hole breaks?

Should Be Inspected

By H. F. Fifield

Engineer Maintenance of Way, Boston & Maine, Boston, Mass.

When joint bars are being renewed or are removed for any other reason, the rail ends should be inspected carefully at that time for incipient cracks at the bolt holes, as well as for cracks in the fillet. This practice should be carried out when the joint bars are removed for any purpose because all rails, regardless of their weight or the type of joint bars used, are liable to develop such cracks or show failure with continued use.

The use of a rail-inspecting mirror will assist in the inspection for minor cracks in the fillet, as well as around the bolt holes. Before the joint bars are replaced, the rail within the area of the joint and the joint bars should be carefully oiled.

Yes, Inspect Carefully

By J. B. Kelly

General Roadmaster, Minneapolis, St. Paul & Sault Ste. Marie, Stevens Point, Wis.

Most certainly, in all cases of the renewal of joint bars, and especially with the application of crowned joint bars or head shims, the joint section of the web of the rails, including the top and edge of the base and the area of bar contact with the head, should be thoroughly inspected for incipient cracks, and any defective rails discovered should be removed. Such inspection is important, because the discovery of one defect may avert an accident, or at least, an emergency replacement of the rail after final breakage. Emergency replacements interfere with the regular movement of traffic and also involve the hazard of getting men to and from the loca-

tion of replacement and the actual renewal of the rail under unfavorable conditions. The weight of the rail or the design of the joint bars does not alter the need for such inspection, since conditions may exist that will cause the development of cracks or other defects with any size of rail or type of joint.

The final breakage of the head of a rail in the joint area represents a bad condition, as frequent experience with such breaks has shown that the broken piece of the rail head may take an angular position which will tend to deflect the wheel passing over it. Furthermore, the pounding of the wheel treads over the broken area may break the rail in fragments in and beyond the joint during the passage of a train.

Unusual conditions have been known to arise on various roads, usually with 90-lb. rail or lighter, in which the expense of removing all the joint bars for rail inspection was entirely justified, even though no change of joint bars was contemplated. Such inspections, in several instances, have resulted in the removal of a large number of rails with cracked webs in the joint area, before complete breakage occurred. Such inspections, however, would be undertaken only where an unusual number of joint breaks had occurred.

Should Inspect Carefully

By W. Woolsey

Section Foreman, Illinois Central, Chicago

When joint bars are removed for the purpose of renewing them or for any other purpose, the rail ends should be inspected carefully for bolt hole cracks. This opportunity to inspect the rail ends should not be overlooked, because more rail failures occur in the joint area than anywhere else in the rail.

There are a number of reasons for this. The major causes are loose joint bolts and low joints. When the joint bolts are loose and the joint is low, the perpendicular movement of the joint up and down under the wheel loads is greater than normal and the stresses set up in the rail are greater. A portion of such stresses, which should be carried by the joint bar, may be borne by the lower edge of the bolt hole if the joint bolts are loose, and, when this condition exists, small fractures develop at the edge or rim of the bolt hole and may extend at an angle eventually into the rail head or longitudinally between the bolt holes and out to the end of the rail.

Other rail defects also frequently occur in the joint area, such as compound fissures, which may develop downward from the rail head and come to surface at the top of the web. This type of rail failure may exist without any noticeable sign on the running surface of the rail head, in which case it can be detected only when the joint bars are removed. With the heavier rail sections, these conditions are less prevalent, for the heavier sections have been designed with a higher web, which permits the design and application of a stronger joint bar. The greater strength and larger fishing surface of the joint bars on heavier rail tends to eliminate, partially at least, some of the causes of bolt hole fractures.

Welded or Threaded Pipe Railings?

What are the relative merits of screwed and welded connections for pipe railings?

Both Have Disadvantages

By A. E. Bechtelheimer

Assistant Engineer of Bridges, Chicago & North Western, Chicago

Pipe railings with threaded connections are used by many railroads. They may be supported by threaded posts with fittings connected by threaded sections of pipe, and the threaded pipe rails screwed into the post fittings, or the pipe railings may be fastened to ordinary posts with soft metal rivets.

Railings with threaded connections are satisfactory on retaining walls and other structures where they are not subjected to vibration. There is some maintenance work on these installations, however, because the railings fail at the joints because of rust or break at the ends of the fittings.

On bridges, and particularly on open deck bridges, the vibration of the span and the movement of the deck loosen the joints of threaded pipe railings and rust and wear destroy the threads. Under these same conditions, the rivets of pipe railings riveted to the posts fail. Maintenance in either case is difficult, and the renewal of the parts in kind is about the only solution. Brazing is not entirely practicable because a welded connection of the steel nipples or rails to the malleable fittings requires expert workmanship, and, even then, failure of repaired connections occurs frequently. Railings with threaded connections which are supported on structural brackets also fail in the same manner as railings supported directly by the bridge deck. The absence of expansion joints in railings probably accounts for more failures than does the type of joint, and results in broken connections, whether they be welded or threaded.

Railings supported on threaded posts can be reconditioned by providing structural posts with malleable fittings bolted in place, through which the railings pass. This construction makes a good railing and is economical, because the old rails can be reused.

There are many designs for ornamental pipe railings in conjunction with various types of paneling on grade separation structures and on bridges over rivers in cities, having threaded and riveted connections that require costly expenditures for maintenance. Recent installations of railings of all-welded construction on such structures present a pleasing appearance, and give promise of a long service life with little maintenance expense. Such installations appear to be well suited to welded construction because the sections used are quite large. The small pipe sections are not so well suited, and although welded construction is possible with the small sections, it does not seem necessary.

Prefers Welded Construction

By Bridge and Building Master

For several years we have used welding in the repair and maintenance of pipe railings, and all-welded construction for new railings with considerable success. Threaded construction makes a good railing in locations where it is not subjected to vibration. However, a pipe railing of all-welded construction, under the same circumstances, makes just as good a railing if the work is well done, and saves considerable expense, both in the cost of fittings which are eliminated and in the time required for construction. We have had comparable success with all-welded construction as compared to threaded construction, also on railings which are subjected to vibration such as on open deck bridges.

Our practice is to support the pipe railings by hooks, hangers or eyebolts, usually welded or bolted to members of the bridge or to structural posts, and if possible, the railings extend beyond the end supports slightly

and are not fastened. This allows them free play and eliminates any strain due to expansion or contraction.

We have also repaired the threaded type railings by welding, with considerable savings in labor and materials, although the problem of successfully welding the steel pipe to the malleable fittings requires expert workmanship. Each of our bridge and building, and also our plumbing, gangs has one man who is an expert welder. These men were trained several years ago when selected men from each gang were sent to headquarters and given a thorough course in welding. The threaded railings are maintained by welding until their general condition calls for complete renewal, at which time they are replaced by railings of all-welded construction.

In addition to the lower cost of construction and maintenance the all-welded pipe railing also presents a pleasing appearance and can be made with rounded corners or in special shapes at moderate expense as compared to the threaded type.

Spring Cleaning of Right of Way

How far should one go in cleaning the roadbed and right of way before starting the working season? What are the advantages and disadvantages?

Keep As Clean As Possible

By G. S. Crites

Division Engineer, Baltimore & Ohio, Punxsutawney, Pa.

In southern regions where there is no ice or snow, the roadbed and right of way should be kept clean at all times. Such cleanliness is a part of the working season. In regions where the ground is covered with ice and snow for considerable periods, there usually are times when the right of way can be grubbed and cleaned while general track work cannot be done. If properly handled, nearly all right of way cleaning can be completed in the spring before much general track work can be undertaken.

When the snow melts, there are apt to be accumulations of cinders, engine sand, etc., around engine terminals, in yards and over the roadbed in general. Engine terminals should be cared for first, and all such accumulations cleaned up and loaded for disposal with the aid of a crane equipped with a clamshell bucket. During the cleaning, all drainage openings should be checked and cleaned if necessary.

At the same time, if possible, the main switching leads should be cleaned and drained. The procedure in yards will depend upon their condition. If bad, the winter's accumulation of dirt, sand, soot and cinders may be piled between tracks and loaded with a clamshell. The tracks should be cleaned and fresh cinders spread, or, if the accumulated materials will support the tracks satisfactorily, they can be given a light surface and the material put under them. Circumstances will govern the procedure, and it is possible that no two yards will receive exactly the same treatment.

The main tracks should be scraped to avoid dust and to prevent the cinders, sand, etc., from working into the ballast. Mechanical sweepers can be used on tracks ballasted with crushed rock to remove the winter's accumulation of dirt and in cinder ballast a light lift will often dispose of this accumulation satisfactorily. Where conditions are bad, stripping and applying fresh ballast may be necessary.

Generally, there are no disadvantages in cleaning both the roadbed and the right of way in the spring before starting general track work.

Depends on Conditions

By Supervisor of Track

In general, the roadbed and right of way should be kept as clean as possible at all times. However, the amount of cleaning needed in the spring and the amount that can be done, frequently depend upon conditions over which the section foreman has no control, and also depend to a considerable extent upon the climate and the amount and type of traffic.

I see no reason why roads in the south cannot keep their right of way and roadbed reasonably clean throughout the year, programming weed mowing, burning and various policing operations according to the season to fit in with the track work required. On roads that do not mow all of their right of way during the summer, the winter is usually the best season for cutting brush and burning right of way, especially during the periods when the track may be frozen and normal track work cannot be done. When this is being done, all scrap and other material that may have been hidden by grass and weeds during the growing season should be picked up.

In territories, however, that are subjected to long periods of cold weather with heavy snowfall, the problem of right of way and roadbed cleaning during the winter and spring months may be entirely different. In such climates, the working season is usually all too short, and the men are generally busy putting the track up in the best possible shape before winter sets in and in making sure that all ditches and drainage openings are in good condition to handle the water when the snow melts the next spring.

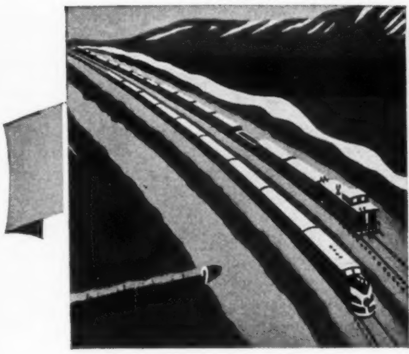
If the track is subject to heaving and the snowfall is heavy, the men are busy all winter with shimming and snow fighting work. In addition, the heavy snow fall makes right of way and roadbed cleaning more or less impractical. The period when the snow begins to melt is also a critical period, drainage must be kept open, and shims removed as fast as the heaved spots go down. However, there is usually a short period before any fall of snow in the fall, and again in the spring before the frost has gone entirely out of the ground, when the track cannot be spotted or surfaced, during which a quick clean up program may be carried out. As soon as the frost is entirely out of the ground, however, it is usually necessary to smooth up the track and start on the tie renewal program. In no case would I prolong roadbed and right of way cleaning after the frost has left the ground and trackwork can be begun.

Should Be Kept Clean

By A. B. Chaney

District Engineer, Missouri Pacific, Little Rock, Ark.

In my opinion every practicable effort should be made to keep all scrap and material picked up currently and, in addition, to clean the right of way of vegetation and scrap during the fall and winter months, with another going over in early spring. It is more economical to clean and burn right of way after the vegetation has been killed and to complete this work before starting the major items of work, such as tie renewals, ballasting, surfacing, etc. During the growing season, some scrap and material will become covered and escape notice. This will be found and picked up during the fall, winter or spring cleanup. This plan also has the advantage of keeping ditches and drains open and free of small drift during the period of greatest rainfall. The principal disadvantage is the increased hazard of fire damage to adjacent property.



NEWS of the Month

Crossing Accident Casualties Increase 19 Per Cent in 1940

Accidents at rail-highway grade crossings in 1940 brought death to 1,808 persons and injuries to 4,632, as compared with 1,398 deaths and 3,999 injuries in 1939, according to the Interstate Commerce Commission's Bureau of Statistics. The 1940 casualties were thus 19.33 per cent above those of the previous year while the number of crossing accidents was up 18.07 per cent, from 3,476 to 4,104. Crossing accidents in which passenger automobiles, trucks or buses were involved accounted for 1,576 of the aforementioned 1,808 fatalities; and for 4,430 of the 4,632 injuries. Pedestrians accounted for 187 of the fatalities, while smaller numbers occurred in accidents involving motorcycles, bicycles and animal-drawn vehicles. The 21.9 per cent increase over 1939 in the casualties in which motor vehicles were involved, the Bureau suggests, "may reflect increased use per vehicle"; because railway traffic, measured in train-miles, increased only 3.68 per cent, while 1940 automobile registrations exceeded 1939 by only 4.2 per cent.

Eastman Says Rational Guidance of Transport Needed

Because of the present competitive struggle in transportation, the great pace of mechanical development and the need for constructive leadership, guidance and planning from the point of view of the transportation system as a whole, Chairman Joseph B. Eastman of the Interstate Commerce Commission, in an address before the American Society of Civil Engineers at Baltimore, Md., on April 23, reiterated his views that there should be a permanent transportation-planning agency and a centralized railroad research bureau.

"Such an agency as I am now suggesting," he stated, "which might or might not take the form of a Department of Transportation, would be divorced from regulation of the kind which requires determination of issues through quasi-judicial procedure; and would instead be what has been called a planning and promotional body. It would issue no orders, but it would be in constant touch with the transportation situation, watching developments, noting trends, discovering opportunities for improvement, and foreseeing dangers ahead. Its influence would be exerted through voluntary co-operation and advice—It might further be given immediate direction of all government activities, outside the field of regulation, which have to do with transportation."

A. A. R. Calls for More Cars in 1942 and 1943

A program calling for a net increase of 120,000 cars for the anticipated traffic of 1942 and a further net addition of 150,000 cars for the traffic of 1943 was adopted by member roads of the Association of American Railroads at its spring meeting at Chicago on May 12. This program is in addition to the one adopted a year ago, which called for the acquisition of 100,000 new cars for handling the 1941 traffic. According to a statement issued by the Association, the railroads will have 1,617,000 serviceable cars when the peak load of 1941 occurs in October. Of these, 168,000 will be new and 27,000 will be cars that have been rebuilt since the war broke out. This will be 156,000 more serviceable cars than they had when they handled the peak business of October, 1939. In addition, they will have 1,000 new locomotives, including 375 steam and 625 electric and Diesel, in service in October.

Discussion of the car-building capacity of plants indicated that car builders have a productive capacity of about 150,000 cars annually, while that of the railroads' own shops is about 60,000 cars a year. Ralph Budd, president of the Chicago, Burlington & Quincy and transportation commissioner of the Advisory Commission to the Council of National Defense, told the meeting that the government attaches the highest importance to the railroads and feels that nothing is more vital to the effective execution of the national defense program than the fullest functioning of the railways. He cautioned the railroads not to make more inroads upon the nation's steel supply than is necessary to carry out their equipment program.

Brotherhoods Ask For 30 Per Cent Increase

A decision to request on June 10, a 30 per cent increase in all basic rates of pay and a minimum money increase of $1.80 per day for all members of the Big Five operating brotherhoods, was made in Chicago on May 19, following a three-day meeting of the general chairmen of the five transportation organizations representing all men employed in engine, train and yard service on railroads in the United States. Other requests which have been under consideration for some time, such as train limits, vacations with pay, and expenses for trainmen while away from home, were not decided upon at the meeting.

A joint statement issued by the heads of the Big Five operating brotherhoods lists four arguments for the pay boost demand as follows:

1. The wages of railway employees are rapidly dropping below wages paid to men in other industries.
2. Soaring prices and the general increased cost of living, including rents and taxes imposed upon employees, are important factors in the situation.
3. In four years the productivity of railroad men has increased 43% without any increase in compensation.
4. Railway employees suffered tremendously from the business depression which engulfed the nation in the early 30's and they feel they have a right now to share in the profits accruing to the railroads as a result of the general increase in the business of the country.

It is estimated that a 30 per cent increase in rates for the 350,000 transportation employees would increase their pay $202,452,000, based upon the $674,841,121 that class I and switching and terminal railroads paid their transportation employees in 1940. The net income of class I railroads in 1940 was only $191,000,000 and of class I and switching and terminal railroads only slightly more.

C. E. Johnston, chairman of the Western Association of Railway Executives, in an informal statement on May 19, said,

"Train and engine service employees now enjoy the highest level of wages in American railroad history. The rail carriers are now straining every effort to co-operate in the National Defense Program, and are making vast capital expenditures to increase their rolling stock and plant facilities in order to handle with dispatch the sudden demands resulting from peak production.

"Almost one-third of the Nation's railroads are still in bankruptcy or reorganization. They are staggering under the burden of deficits accumulated throughout the depression period. The increased productivity of railroad labor, if indeed it has increased, is not due to increased effort on behalf of the employees, but is directly due to improved mechanical efficiency of the railroad plant."

Personal Mention

General

George A. Kirley, chief engineer of the Boston & Albany, has been appointed general manager, with headquarters as before at Boston, Mass.

Christian S. Collier, supervisor of trains and track on the Illinois Central, with headquarters at Princeton, Ky., has been promoted to trainmaster at that point.

J. W. Knapp, Jr., division engineer of the Richmond division of the Chesapeake & Ohio, with headquarters at Richmond, Va., has been promoted to trainmaster with the same headquarters.

R. M. Smith, division engineer of the Missouri and Memphis divisions of the Missouri Pacific, with headquarters at Poplar Bluff, Mo., has been promoted to trainmaster, with headquarters at Bush, Ill.

J. G. Hunter, supervisor of bridges and buildings of the Radford division of the Norfolk & Western, with headquarters at Roanoke, Va., has been promoted to assistant superintendent of the Shenandoah division, with the same headquarters, to replace **B. H. Maben,** who has been transferred to the Norfolk division with headquarters at Crewe, Va., to succeed **H. T. Reinicker,** who has retired.

A. Mosby Harris, whose promotion from supervisor of track to assistant superintendent of freight transportation of the Western region of the Pennsylvania, with

A. Mosby Harris

headquarters at Chicago, was announced in the April issue of *Railway Engineering and Maintenance*, was born at Richmond, Va., on August 7, 1907, and attended Virginia Polytechnic Institute from 1927 to 1931. He entered railway service on June 15, 1931, as an assistant on the engineering corps of the Pennsylvania at Washington, D. C., later being transferred to Baltimore, Md., and Tyrone, Pa. On April 9, 1934, he was promoted to assistant supervisor of track at Clayton, Del., and was later transferred successively to Harrington, Del., Wilmington, Downingtown, Pa., and Harrisburg. In May, 1937, Mr. Harris was advanced to supervisor of track at Olean, N. Y., and in February, 1938, he was assigned to special duty in the office of the chief engineer at Philadelphia. On April 1, 1939, he was appointed supervisor of track at Johnstown, Pa., the position he held until his recent promotion.

Engineering

T. L. Pidcock, assistant engineer on the Idaho division of the Union Pacific, has been promoted to division engineer, with headquarters at Pocatello, Idaho.

L. E. Gingerich, division engineer on the Pennsylvania, with headquarters at Chicago, has been promoted to division engineer in the office of the chief engineer at Philadelphia, Pa.

Benjamin Elkind, chief draftsman on the Erie at Cleveland, Ohio, has been promoted to office engineer, a newly created position, with the same headquarters, and **Howard M. Shepard** has been appointed chief draftsman, succeeding Mr. Elkind.

Charles E. Hise, principal assistant engineer of the Chicago, St. Paul, Minneapolis & Omaha, has been promoted to assistant chief engineer, with headquarters as before at St. Paul, Minn., and the position of principal assistant engineer has been abolished.

J. W. Treadwell, roadmaster on the Missouri Pacific at Benton, Ark., has been promoted to division engineer of the Missouri and Memphis divisions, with headquarters at Poplar Bluff, Mo., succeeding **R. M. Smith,** whose promotion to trainmaster, with headquarters at Bush, Ill., is announced elsewhere in these columns.

The jurisdiction of **J. W. Pfau,** chief engineer, and **W. A. Murray,** engineer maintenance of way of the New York Central, Lines East, at New York, has been extended to include the Boston & Albany. **Louis G. Morphy,** receiver of the Rutland, has been appointed district engineer of the Boston & Albany, with headquarters at Boston, Mass.

H. A. Lathrop, assistant engineer in the appropriations bureau of the Southern Pacific at San Francisco, Cal., has been appointed office engineer, with the same headquarters, and **W. T. Black,** assistant division engineer at El Paso, Tex., has been appointed assistant engineer in the appropriations bureau at San Francisco, succeeding Mr. Lathrop. **H. C. Stull,** assistant division engineer on the Coast division, has been transferred to El Paso, relieving Mr. Black.

E. H. McGovern, division engineer on the New York Central, with headquarters at Chicago, has been promoted to assistant district engineer, with headquarters at Cincinnati, Ohio, succeeding to the duties of **William Christian Kegler,** engineer of track and roadway of the Cleveland, Cincinnati, Chicago & St. Louis (Big Four), whose death on May 6 is reported elsewhere in these columns. **G. H. Smith,** division engineer at Columbus, Ohio, has been transferred to Chicago, replacing Mr. McGovern and **C. V. Bucher,** assistant engineer in the office of the division engineer at Cleveland, Ohio, has been promoted to division engineer at Columbus, relieving Mr. Smith. The position of engineer of track and roadway at Cincinnati has been abolished.

Charles H. Splitstone, whose appointment as assistant chief engineer of the Erie, with headquarters at Cleveland, Ohio, was reported in the May issue, was born at Linesville, Pa., on January 19,

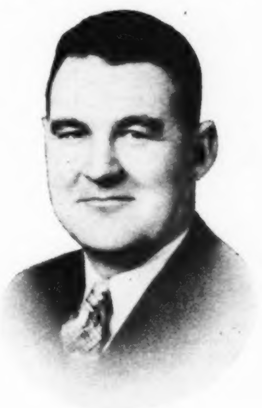
Charles H. Splitstone

1878, and attended Pennsylvania State College. He entered railway service in 1901 as a rodman on the Pennsylvania, Lines West of Pittsburgh, at Bedford, Ohio. In 1903 he was promoted to chief of party, with headquarters at Chicago, and two years later was transferred to Pittsburgh, Pa. Mr. Splitstone went with the Erie in 1906 as a chief of party, later being promoted to resident engineer. In 1909 he was advanced to chief draftsman, with headquarters at New York, and four years later he was promoted to office engineer. In 1917 he was further advanced to superintendent of construction and in 1931, his headquarters were transferred to Cleveland, Ohio.

Reginald T. Blewitt, whose promotion to designing engineer of the New York, Chicago & St. Louis (Nickel Plate), with headquarters at Cleveland, Ohio, was announced in the April issue, was born at Barrow-in-Furness, England, on August 11, 1894, and attended Barrow Technical School. He entered railway service on April 1, 1914, as an apprentice civil engineer with the Furness Railway Company (now the London, Midland & Scottish), and three years later he served as an apprentice engineer for five months on 4½ miles of subway extension. During the first World War, Mr. Blewitt served at Gallipoli, and in Egypt, France, Belgium and Italy, first with the Royal Naval Division Engineers, then as a second lieutenant in the Royal Engineers, 101st Field Company, 23rd Division. After the war he became permanent way engineer for the Barrow Hematite Steel Company, Ltd., a temporary position for the purpose of reorganizing its transportation system. Mr. Blewitt came to the United States in November, 1920, and in July, 1922, re-entered railway service as a draftsman in the track department of the New York Central. On December 1, 1924, he went with the Nickel Plate as an assistant engineer and on February 1, 1927, he was appointed structural designer in the

bridge department, the position he held until his recent promotion.

A. L. Keine, whose promotion to division engineer on the Denver & Rio Grande Western, with headquarters at Salt Lake City, Utah, was reported in the May issue, was born at Mexico, Mo., on May 7, 1903, and studied civil engineering at Kansas University. He entered



A. L. Keine

railway service in June, 1919, as a section laborer on the Missouri division of the Atchison, Topeka & Santa Fe, later serving as assistant extra gang foreman, extra gang foreman, chainman, rodman, transitman and acting roadmaster. Mr. Kleine later went with the D. & R. G. W. as a track inspector at Dotsero, Colo., and was subsequently promoted to assistant roadmaster at Grand Junction, Colo. In March, 1939, he was promoted to assistant engineer of track, with headquarters at Denver, and a short time later was appointed tie inspector. In September, 1939, he was promoted to roadmaster, with headquarters at Helper, Utah, which position he held until his recent promotion.

W. W. Wilson, whose appointment as acting chief engineer of the Gulf, Colorado & Santa Fe, with headquarters at Galveston, Tex., was announced in the

W. W. Wilson

May issue has been appointed, effective June 1, chief engineer of the G. C. & S. F. Mr. Wilson was born at Hearne, Tex., on January 2, 1882, and graduated in civil engineering from the University of Texas in 1906. Prior to his graduation, he served the G. C. & S. F. as a track laborer from January, 1899, until January, 1901, and as an axeman in the engineering department from the latter date until September, 1902, on which date he left the service to enter school. In June, 1906, he re-entered the service of the G. C. & S. F. as a transitman on construction and maintenance and in April, 1909, he was promoted to assistant engineer on the Beaumont division. In January, 1910, Mr. Wilson was advanced to division engineer of the Galveston division, with headquarters at Galveston, and from November, 1918, until April, 1920, during federal control of the railways, he served as engineer maintenance of way of the Galveston Terminal Association, returning to the G. C. & S. F. as division engineer on the latter date. He was later transferred to the Southern division at Temple, Tex., and on August 15, 1930, he was advanced to district engineer, with headquarters at Galveston. In the latter part of 1939, the position of district engineer at Galveston was abolished, and Mr. Wilson was appointed division engineer, with the same headquarters, the position he held until his recent promotion.

W. G. Powrie, engineer of water service and assistant superintendent of track maintenance of the Chicago, Milwaukee,

W. G. Powrie

St. Paul & Pacific, has been promoted to engineer maintenance of way, a newly created position, with headquarters as before at Chicago, and **William Shea,** superintendent of track maintenance, has retired at his own request after 57 years service. The positions of superintendent of track maintenance, and of engineer of water service and assistant superintendent of track maintenance have been abolished.

Mr. Powrie was born at Milwaukee, Wis., on August 5, 1904, and first entered railway service in 1920 with the Milwaukee, at which time he served for three months. He returned to the service of this company in 1923 as a chainman in the district engineer's office at Minneapolis, Minn., being advanced successively through the positions of rodman and instrumentman. Five years later he was promoted to assistant engineer at Mason City, Iowa, and on January 1, 1930, he was appointed assistant to the general supervisor of bridges and buildings at Chicago. In 1931 Mr. Powrie was promoted to division engineer of the Iowa and Southern Minnesota division, with headquarters at Austin, Minn., being transferred to Savanna, Ill., later in the same year. In August, 1932, he was appointed assistant engineer at Chicago, in which capacity he was in charge of water service matters. In the spring of 1935 he was appointed engineer of water service, and on November 1, 1937, he was appointed also assistant

William Shea

superintendent of track maintenance. His appointment as engineer maintenance of way was effective May 16.

Mr. Shea was born at Eddyville, Iowa, on August 31, 1867, and entered railway service in 1881 as a water boy on the construction of the Humeston & Shenandoah (now part of the Chicago, Burlington & Quincy) in southwestern Iowa. He later served as foreman of a construction gang for the Milwaukee on the construction of the line between Cedar Rapids, Iowa, and Ottumwa. On November 1, 1884, he was appointed section foreman on the same line at North English, Iowa, and in August, 1887, he was promoted to extra gang foreman on the Kansas City division. Mr. Shea was advanced to roadmaster on the Chicago and Council Bluffs division in 1890, and on January 1, 1891, he was appointed roadmaster on the Middle district of the Kansas City division, with headquarters at Blakesburg, Iowa. In July, 1918, he was further advanced to general roadmaster of the Milwaukee system, with headquarters at Chicago. In January, 1930, Mr. Shea was appointed assistant engineer of maintenance of way and on May 1, 1935, his title was changed to superintendent of track maintenance, the position he held until his retirement, which was effective May 1.

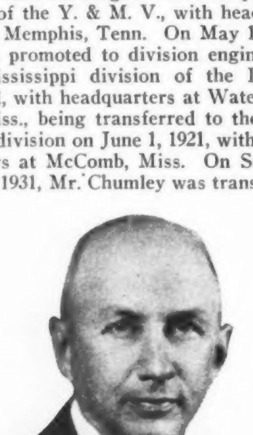
Charles M. Chumley, district engineer of the Southern lines of the Illinois Central, with headquarters at Memphis, Tenn., has been promoted to engineer maintenance of way of the system, with headquarters at Chicago, succeeding **Lewis H. Bond,** chief engineer maintenance of way, who retired on May 31. **John E. Rogan,** trainmaster of the New Orleans terminal, has been promoted to assistant engineer maintenance of way, with headquarters at Chicago, and **George M. O'Rourke,** district engineer of the Northern lines, has been appointed assistant engineer maintenance of way, with headquarters as before at Chicago. The positions of district

engineer at Chicago and Memphis have been abolished.

Mr. Chumley was born at Union City, Tenn., on May 21, 1882, and entered railway service on March 16, 1903, in the bridge and building department of the Yazoo & Mississippi Valley (part of the Illinois Central system), at Baton Rouge, La. From February, 1905, to September, 1906, he served as a clerk and storekeeper at Harriston, Miss., then being appointed bridge and building foreman on the New Orleans division of the Y. & M. V. In

Charles M. Chumley

October, 1907, Mr. Chumley was promoted to general foreman in the bridge and building department of the same division, which position he held until December, 1909, when he was made supervisor of bridges and buildings of the Memphis division of the Y. & M. V., with headquarters at Memphis, Tenn. On May 1, 1920, he was promoted to division engineer of the Mississippi division of the Illinois Central, with headquarters at Water Valley, Miss., being transferred to the Louisiana division on June 1, 1921, with headquarters at McComb, Miss. On September 23, 1931, Mr. Chumley was transferred



Lewis H. Bond

to the Kentucky division, with headquarters at Paducah, Ky., and on June 10, 1937, he was promoted to district engineer of the Southern lines, with headquarters at Memphis.

Mr. Bond was born at Louisville, Ky., on November 14, 1879, and graduated from the Du Pont Technical College in 1898. He entered railway service in September, 1899, as a chainman on the Illinois Central, and later served as a rodman and instrumentman until June, 1904, when he was promoted to assistant engineer. He was promoted to supervisor in December, 1905, and in August, 1908, he was reappointed assistant engineer. From June, 1910, until June, 1917, he served as roadmaster, being promoted to assistant engineer maintenance of way on the latter date. He was appointed district engineer of the Northern district, with headquarters at Chicago, in June, 1919, and was reappointed assistant engineer maintenance of way in January, 1923. In February, 1925, Mr. Bond was promoted to engineer maintenance of way of the system, with headquarters at Chicago, and in August, 1938, his title was changed to chief engineer maintenance of way.

Track

E. C. Barnes has been appointed roadmaster on the Denver & Rio Grande Western, with headquarters at Minturn, Colo., succeeding **O. M. Flatberg.**

D. L. Cutler, a section foreman on the Milwaukee division of the Chicago, Milwaukee, St. Paul & Pacific, has been promoted to roadmaster, with headquarters at Horicon, Wis., succeeding **J. H. Johns,** who retired on May 1.

William Fuller, a section foreman on the H. & D. division of the Chicago, Milwaukee, St. Paul & Pacific, has been promoted to roadmaster, with headquarters at Glencoe, Minn., succeeding **J. F. Larson,** who retired on May 1.

S. P. Critz, instrumentman on the Illinois Central at Memphis, Tenn., has been promoted to track supervisor, with headquarters at McComb, Miss., succeeding **O. A. Graham,** whose death on April 20 was announced in the May issue.

C. A. Colpitts, transitman on the Edmonton division of the Canadian Pacific, has been promoted to roadmaster, with headquarters at Lloydminster, Alta., succeeding **R. D. Currie,** who died from injuries received in an accident on April 12.

A. F. Trautman, assistant roadmaster on the Chicago, St. Paul, Minneapolis & Omaha at St. Paul, Minn., has been transferred to Emerson, Neb., succeeding **J. W. Hendrickson,** who in turn has been transferred to St. Paul, replacing Mr. Trautman.

Q. M. Young, section foreman on the Louisiana division of the Illinois Central, has been promoted to track supervisor, with headquarters at Yazoo City, Miss., succeeding **H. A. Mercer,** whose retirement on May 1 was announced in the May issue.

N. P. Patterson, assistant on the engineer corps of the Eastern region of the Pennsylvania, has been promoted to assistant supervisor of track, with headquarters at Cresson, Pa., to succeed **P. S. Settle,** who has been transferred to Wilmington, Del. **C. F. Grigg,** assistant on the engineer corps at Baltimore, Md., has been advanced to assistant supervisor of track at York, Pa., to succeed **P. O. Hansen,** who has been transferred to Baltimore. **C. H. Baker,** assistant on the engineer corps of the Central region, has been promoted to assistant supervisor of track at Northumberland, Pa.

Victor Hultberg, section foreman on the Canadian Pacific at Erskine, Alta., has been promoted to roadmaster, with headquarters at Wetaskiwin, Alta., succeeding **E. Bye,** who has retired.

W. J. Dixon has been appointed supervisor of track on the Chesapeake & Ohio, with headquarterse at Cane Fork, W. Va., to succeed **J. A. Bragg,** whose appointment as assistant division engineer is noted elsewhere in these columns.

John H. Dame, section foreman on the Illinois Central at Paducah, Ky., has been promoted to track supervisor at Princeton, Ky., succeeding to a portion of the duties of **Christian S. Collier,** supervisor of trains and track, whose promotion to trainmaster, with headquarters at Princeton, is reported elsewhere in these columns.

J. G. Beard, assistant to the roadmaster on the Southern at Somerset, Ky., has been promoted to track supervisor on the St. Louis division, with headquarters at Huntingburg, Ind., succeeding **J. E. Nitzschke,** who has been transferred to Princeton, Ind. Mr. Nitzschke replaces **C. I. Parsons** who has been transferred to Birmingham, Ala., relieving **A. W. Stone.** Mr. Stone has been transferred to Oakdale, Tenn., succeeding **J. P. Mumford.**

Bridge and Building

A. E. Reynolds, a system bridge and building foreman on the Chicago, Burlington & Quincy, has been promoted to master carpenter of the Ottumwa-Creston divisions, with headquarters at Burlington, Iowa, succeeding **C. Landstrom,** who retired on May 1.

G. A. Meier, bridge and building foreman on the Idaho division of the Union Pacific, has been promoted to supervisor of bridges and buildings, with headquarters at Nampa, Idaho. **B. E. Arnold,** bridge and building foreman on the Nebraska division, has been promoted to supervisor of bridges and buildings, with headquarters at Omaha, Neb.

H. B. McColgan, assistant supervisor of bridges and buildings of the Scioto division of the Norfolk & Western, with headquarters at Portsmouth, Ohio, has been promoted to supervisor of bridges and buildings of the Radford division, with headquarters at Roanoke, Va., to succeed **J. G. Hunter,** whose appointment as assistant superintendent is noted elsewhere in these columns. **R. F. Alley,** assistant roadmaster of the Buchanan branch of the Pocahontas division, with headquarters at Grundy, Va., has been promoted to assistant supervisor of bridges and buildings at Portsmouth, to replace Mr. McColgan.

Obituary

C. T. Nelson, retired supervisor of metal bridges of the Atlantic Coast Line, died at Florence, S.C., on April 26.

(Continued on page 434)

William Christian Kegler, engineer of track and roadway of the Cleveland, Cincinnati, Chicago & St. Louis, with headquarters at Cincinnati, Ohio, died May 6.

Robert H. Ford, who retired as chief engineer of the Chicago, Rock Island & Pacific on September 30, 1939, died on May 27 at his home in Chicago following an illness of several weeks. Mr. Ford was born at St. Albans, Vt., on September 8, 1869, and was educated in Norwich University, Northfield, Vt., graduating in 1892. He entered railroad service in the same year with the Central Vermont, with which road he served for 13 years as a roadmaster and in other capacities on construction and maintenance. In 1906, Mr. Ford left this company to go with the Missouri Pacific as an assistant engineer, later being appointed maintenance of way inspector. In 1907, he was promoted to principal assistant engineer, and in 1909 he was further advanced to assistant to the chief engineer maintenance of way. Resigning from the Missouri Pacific in 1911, Mr. Ford joined the Hodges-Downey Construction Company, Birmingham, Ala., general contractors, as chief engineer. In

Robert H. Ford

1913, he left this company to go with the Rock Island as a special engineer, being appointed engineer track elevation in the following year, in charge especially of the large program of grade separation in Chicago. In 1919, Mr. Ford was promoted to principal assistant engineer, and in 1924 he was further advanced to assistant chief engineer. Mr. Ford was appointed chief engineer of the Rock Island on April 1, 1937, holding that position until his retirement. During his career, Mr. Ford had given much time to the broader aspects of transportation engineering, especially in relation to the effect on the railways of the development of the system of inland waterways in the Mississippi Valley. Mr. Ford was active in the affairs of the American Railway Engineering Association for many years, and served as its president and as chairman of the Engineering division of the Association of American Railroads in 1935-36. He has also served as chairman of various committees of the A. R. E. A. Mr. Ford was a member of the board of trustees of Norwich University for a number of years, and that institution conferred upon him the honorary degree of Doctor of Engineering in 1939.

Joseph Mayo Metcalf, assistant chief engineer of the Missouri-Kansas-Texas Lines, with headquarters at St. Louis, Mo., whose death on March 23 was reported in the May issue, was born in

Joseph Mayo Metcalf

Elyria, Ohio, on October 30, 1880, and graduated from Oberlin College in 1901 and Harvard University in 1902. He entered railway service in 1902 as a chainman on the Atchison, Topeka & Santa Fe, later being promoted successively to rodman, inspector, computer, transmitman and assistant engineer. In 1907 he went with the Chicago, Milwaukee, St. Paul & Pacific and served during that year and the following year as an instrumentman and resident engineer in Montana and Idaho. Mr. Metcalf went with the M-K-T in 1909 as an assistant engineer and was later advanced successively to division engineer and principal assistant engineer. In 1928 he was promoted to assistant chief engineer.

Herman J. Pfeifer, consulting engineer and former chief engineer of the Terminal Railroad Association of St. Louis, whose death in that city on March 16 was reported in the April issue, was born in St. Louis on February 23, 1871. He graduated from St. Louis University in 1889 and attended the Washington University

Herman J. Pfeifer

School of Engineering for one year. He entered railway service on April 28, 1892, as a rodman and draftsman for the St. Louis Merchants Bridge Terminal Railway (now part of the Terminal Railroad Association of St. Louis), and in August, 1893, he was transferred to chief engineer's office of the Terminal Railroad Association. In 1896 he was promoted to assistant engineer and on January 1, 1902, he was advanced to principal assistant engineer. Mr. Pfeifer left the service of the T. R. R. A. on August 1, 1902, to become general superintendent of street construction for the city of St. Louis, and on September 1, 1905, he returned to the T. R. R. A. as engineer maintenance of way. During the period of federal control of the railroads, he was appointed chief engineer of the St. Louis and East St. Louis Terminal district and returned to the T. R. R. A. as chief engineer in 1920. On February 17, 1941, Mr. Pfeifer was appointed consulting engineer.

Robert Farnham, assistant chief engineer of the Eastern region of the Pennsylvania, with headquarters at Philadelphia, Pa., whose death on April 8 was reported in the May issue, was born in Washington, D.C., on December 19, 1877, and attended private schools in Washington and the George Washington University. He was

Robert Farnham

graduated from Lehigh University in 1899 with the degree of civil engineer, following which he served in the engineering department of the District of Columbia for a period of three years on the designing and construction of highways and bridges. From May, 1902, to March, 1903, he was employed by an engineering firm in New York City. Mr. Farnham entered the service of the Pennsylvania on March 9, 1903, as a levelman on an engineering corps, and in August of the same year he was appointed assistant engineer of construction and placed in charge of the construction work for the Pennsylvania in connection with the building of Union Station in Washington. On the completion of that project he returned to Philadelphia in the office of the engineer of bridges and buildings as an assistant engineer. On April 1, 1923, he was promoted to engineer of bridges and buildings on that portion of the Pennsylvania east of Pittsburgh. On February 15, 1927, Mr. Farnham was appointed chief engineer of an extensive program of improvements at Philadelphia, including the construction of Pennsylvania station at 30th street. He was appointed assistant chief engineer of the Eastern Region on September 16, 1937.

(Continued on page 436)

Association News

Roadmasters Association

The Executive committee will meet in Chicago on July 21. The Proceedings are now in the hands of the printer and will be mailed to the members late in June.

Metropolitan Maintenance of Way Club

The annual outing of the club will be held at the Houvenkopf Country Club, Suffern, N.Y., on Thursday, June 26. The activities of the day will consist principally of sports, including golf, soft ball, horse shoes and quoits, with prizes being awarded in all events. A buffet luncheon will be served at noon.

Bridge and Building Association

The Executive committee met in Chicago on April 28, with President H. M. Church, Vice-Presidents R. E. Dove, F. H. Soothill, and A. M. Knowles; Secretary F. O. Whiteman; Treasurer F. E. Weise; Directors Neal D. Howard, and I. A. Moore; Past-Presidents A. E. Bechtelheimer and Elmer T. Howson; and Committee Chairmen J. P. Hanley and A. B. Chapman, present. After considering the status of the membership at length, 19 applications were acted upon favorably.

I. A. Moore, chairman of a committee appointed to consider the advisability of establishing a junior membership grade, presented a report recommending this action, which report was approved and the committee was instructed to draft an amendment to the by-laws to be presented at the next Executive committee meeting. President Church reported that a number of A.R.E.A. committees had advised him of their plans to schedule meetings during the 1941 annual convention.

The Executive committee then gave detailed consideration to the status of the Proceedings, especially to the format and editorial standards therefor and voted to accept recommendations leading to their improvement. The Proceedings will be available for distribution to members in July.

Tie Producers

The Railway Tie Association held its twenty-third annual convention at Hot Springs, Ark., on May 21-22, with an attendance of approximately 90 producers of crossties and railway officers interested in their use. The convention gave detailed consideration to the problems of increasing production to meet the increased demands of the railways and those of national defense, which latter demands, as yet unfilled, were reported as large as 6,000,000 ties.

Officers elected for the ensuing year include the following: President, Leonard Perez (re-elected); first vice-president, J. J. Schlafly, president, Potosi Tie & Lumber Company, St. Louis, Mo.; second vice-president, R. M. Claytor, plant manager, Southern Wood Preserving Company, Chattanooga, Tenn.; secretary-treasurer, Roy M. Edmonds (re-elected); directors, R. M. Hamilton, vice-president, T. J. Moss Tie Company, St. Louis; John Renfro, secretary, Taylor-Colquitt Company, Spartanburg, S.C.; A. A. Savage, vice-president, Bond Brothers, Inc., Birmingham, Ala.; Ricker A. Van Metre, president, Wyoming Tie & Timber Company, Chicago; Ralph E. Meyers, vice-president and sales manager, International Creosoting & Construction Company, Galveston, Tex.

American Railway Engineering Association

Seven committees of the association held meetings during May in various parts of the country and Canada, and June promises to witness equally as large activity, with six committees already scheduling meetings in this month. The committees which met in May were Rail, at Chicago, on May 2; Buildings, at Montreal, Que., on May 5 and 6; Records and Accounts, at Louisville, Ky., on May 7 and 8; Ties, at Russell, Ky., on May 15 and at Radford, Va., on May 16; Iron and Steel Structures, at Niagara Falls, N.Y., on May 15 and 16; Co-operative Relations With Universities, at Bethlehem, Pa., on May 26; and Wood Bridges and Trestles, at Chicago, on May 28.

The committees which have scheduled meetings in June include the following: Roadway and Ballast, at Toronto, Ont., on June 2 and 3; Track, at Chicago, on June 12; Yards and Terminals, at Cleveland, Ohio, on June 16; Water Service, Fire Protection and Sanitation, at St. Louis, Mo., on June 20 and 21; Maintenance of Way Work Equipment, at New Haven, Conn., on June 21 and 22; and Highways, at Chicago, on June 24.

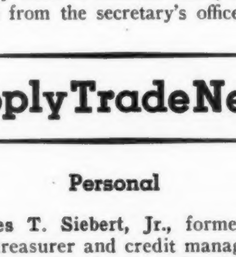
The 1941 Proceedings, reporting the activities of the convention last March, are in the hands of the printer and will be mailed to members during the first week in June. This volume will have 1166 pages, compared with 1046 pages in the 1940 Proceedings, and will be the largest since 1934. The looseleaf supplements to the Manual, comprising 148 sheets, are now on the press, and will be distributed to holders of the Manual about July 1, after they have been approved by the Engineering division and the Operations and Maintenance department of the A.A.R. The first 87 revised trackwork plans of the association and a temporary table of contents sheet, are now available from the secretary's office.

Supply Trade News

Personal

Charles T. Siebert, Jr., formerly assistant treasurer and credit manager, has been appointed assistant to the vice-president in charge of sales of the **Carnegie-Illinois Steel Corporation,** Pittsburgh, Pa.

Samuel S. Bruce, Jr., has been appointed sales representative of the **Duff-Norton Manufacturing Company,** with headquarters at the company's general offices in Pittsburgh.



John H. Collier, vice-president of the **Crane Company,** Chicago, has been elected president to succeed **Charles B. Nolte,** whose death on April 29 is announced elsewhere in these columns. Mr. Collier was born in 1884 and was educated at Purdue University. He entered the employ of the Crane Company in 1903 as a core makers helper and after holding various positions with the company was made

John H. Collier

general manager of the Bridgeport, Conn., plant in 1917. In 1929 he was sent to Paris as president of the company's French subsidiary and for the next four years served in that capacity and as chairman of the company's English subsidiary. In 1933 he returned to the United States and was elected vice-president in charge of manufacturing.

Dwight Richards, whose appointment as chief engineer of the railroad division of the **Buda Company,** Harvey, Ill., in charge of the development of new products, was reported in the May issue, is an engineering graduate of Ohio State University. Early in his career he was associated with

Dwight Richards

the Insley Manufacturing Company, Indianapolis, Ind., and the Marion Steam Shovel Company, Marion, Ohio, in an engineering capacity. He later became chief engineer for the Myers-Whaley Company, Knoxville, Tenn., manufacturers of coal and rock loading machinery. In 1933 he

(Continued on page 438)

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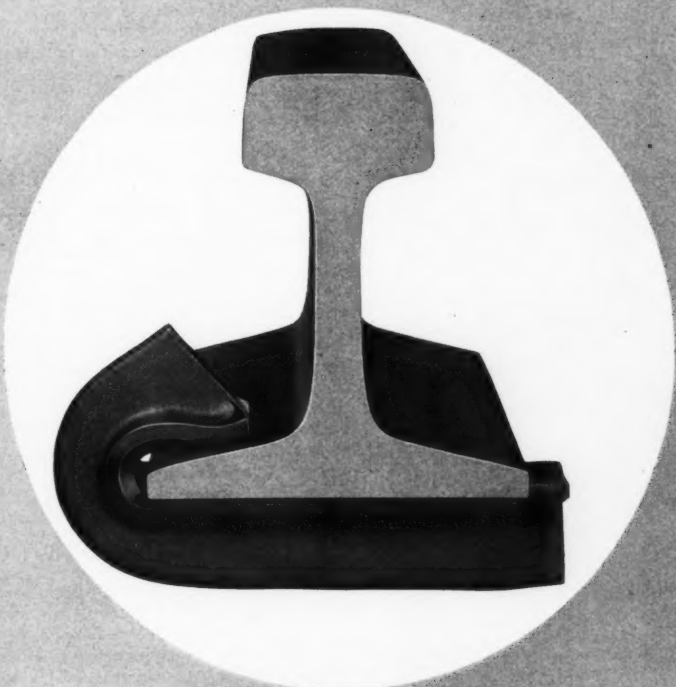

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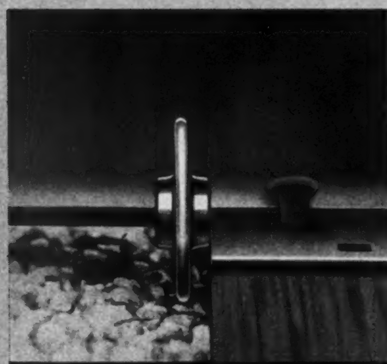

↑ Bearing against tie plate

↑ Bearing against tie

↑ Bearing against both tie and tie plate

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went with the Sullivan Machinery Company as chief engineer of the English Company in England, in charge of the design of coal mining machinery, hoists, drills, etc. Mr. Richards was with the Sullivan Machinery Company until July, 1940, when, due to the war, he returned to America.

Stephen P. Murphy, who until recently had been serving as chief operator on a Sperry detector car for the **Sperry Rail Service** has been transferred to the company's Hoboken, N.J., office as eastern sales representative to replace **Thomas E. Gilhooley,** who has been called to active duty by the United States Army.

Fowler McCormick, second vice-president in charge of manufacturing of the **International Harvester Company,** Chicago, has been elected president to succeed **Sydney G. McAllister,** who has been elected chairman of the executive committee, a position that has been vacant since the death of Addis E. McKinstry. **K. O. Schreiber,** assistant to vice-president, succeeds Mr. McCormick.

Wilfred Sykes has been elected president of the **Inland Steel Company,** Chicago, succeeding **Philip D. Block,** who has been elected chairman of the executive committee. **L. E. Block,** who served as chairman of the board for many years prior to 1940, has been elected chairman of the finance committee. **James H. Walsh,** works manager of Inland's Indiana Harbor works has been elected vice-president in charge of steel works.

Mr. Sykes was born in New Zealand and started his career in Melbourne, Australia. In 1909 he served as a steel mill engineer for the Westinghouse Electric and Manufacturing Company and from 1920 to 1922 was employed as executive engineer by the Steel and Tube Company of America at Chicago. His association with Inland began in 1923 when he was employed to take charge of construction and engineering work. From 1927 to 1930 he served as assistant general superintendent of the Indiana Harbor Works and since 1930 he has been assistant to the president. He is also chairman of the Milcor Steel Company and the Wilson &

Wilfred Sykes

Bennett Manufacturing Company, two of Inland's subsidiary organizations.

Mr. Philip D. Block, who retires from the presidency to become chairman of the executive committee, was one of the original founders of the company in 1893. Since that time he has been a dominant force in developing the concern from a small re-rolling mill into one of the major steel companies in the country and the largest independent producer in the Chicago area. Mr. Block served as a vice-president of

Philip D. Block

the company prior to 1919 when he became president.

Mr. Walsh, who has been elected vice-president was assistant general superintendent of the Indiana Harbor Works

James H. Walsh

from 1922 to 1927 and general superintendent from 1927 to 1930. In the latter year he was promoted to works manager.

Obituary

Alex S. Anderson, district manager of the midwestern territory of the **Duff-Norton Manufacturing Company,** with headquarters at Chicago, died in that city on April 29, after a month's illness. A biographical sketch and photograph of Mr. Anderson were published in the April issue, following his appointment with the Duff-Norton Manufacturing Company.

Charles B. Nolte, president of the **Crane Company,** Chicago, died suddenly on April 29, following a heart attack. Mr. Nolte graduated from the University of Illinois in 1909, and soon after entered the employ of Robert W. Hunt & Co., Chicago. He served as inspecting and testing engineer in various departments of this company until 1913, when he was appointed manager of the railway materials, inspection and testing department. In 1919 he was

Charles B. Nolte

appointed assistant to the president and in 1923, when the company was incorporated under the name of the Robert W. Hunt Company, he was elected vice-president and general manager. In October, 1930, he was elected president and general manager. He resigned in 1935 to become president of the Crane Company.

Trade Publications

Johns-Manville Industrial Products.—This is the title of a 52-page illustrated catalog issued by Johns-Manville, New York, in which is described and illustrated the more important industrial products manufactured by this company.

Cooldown Method of Boiler Washing.—The National Aluminate Corporation and the Paige-Jones Chemical Company, Chicago, have published bulletin 411, which discusses controlled heating and cooling to protect the service life of locomotive boilers and explains the cooldown system of boiler washing. The bulletin contains photographs illustrating scale formation and a plan showing the piping arrangement required for the cooldown method of boiler washing.

Fractures Under Engine Burns.—Sperry Products, Inc., Hoboken, N.J., has issued Vol. 10, No. 4 of the Sperry Review, which is devoted entirely to a discussion of internal fractures under engine burns. This issue contains eight pages and is profusely illustrated, especially with photographs showing various types of fractures attributable to engine burns. The publication also contains a discussion of the improved detection equipment, especially designed for the detection of internal defects under engine burns, with which all Sperry detector cars are now fitted.

Koppers Kolineum.—Bulletin TD-11 has been published by the Koppers Company, Tar and Chemical Division, Pittsburgh, Pa., featuring Koppers Kolineum, a highly refined creosote, used as a wood preservative, insecticide and weed killer. The physical properties of Kolineum are described, and directions are given for preserving wood by dipping, brushing and spraying with it, and for using it as an insecticide and a weed killer.

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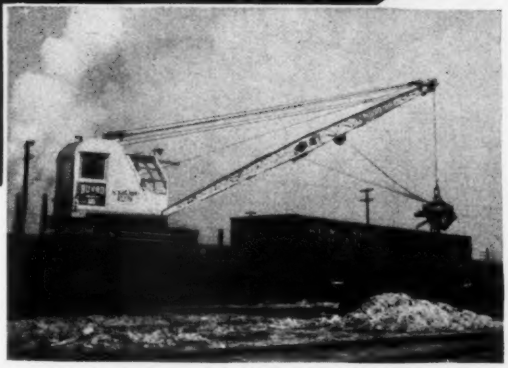

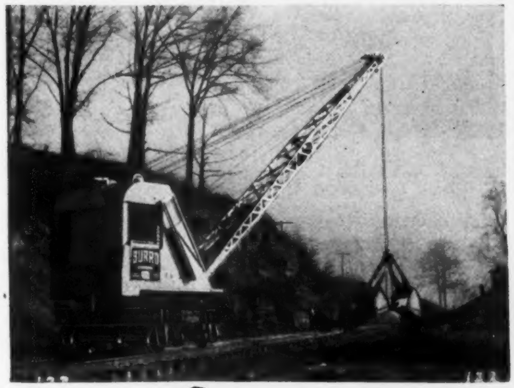

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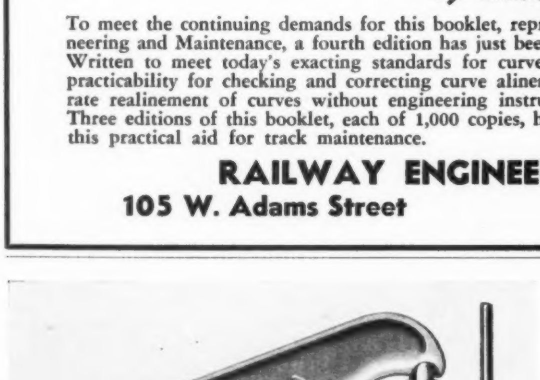

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